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ABSTRACT

This report summarizes a study to help member States compare their expenditures on educational facilities and to analyze their capital costs in the context of national resources and educational and social objectives. Sponsored by UNESCO, the study covered 14 UNESCO member States in Africa, Asia, and Latin America; and included visits to some 100 secondary schools, the bulk of which were constructed during 1960-70. The report attempts to help educational administrators understand the value of undertaking surveys of this type and the importance of making the planning of educational facilities an integral part of their educational planning activities. The appendixes will be of particular interest to architects, engineers, and administrators responsible for the design and construction of educational buildings. (Author)

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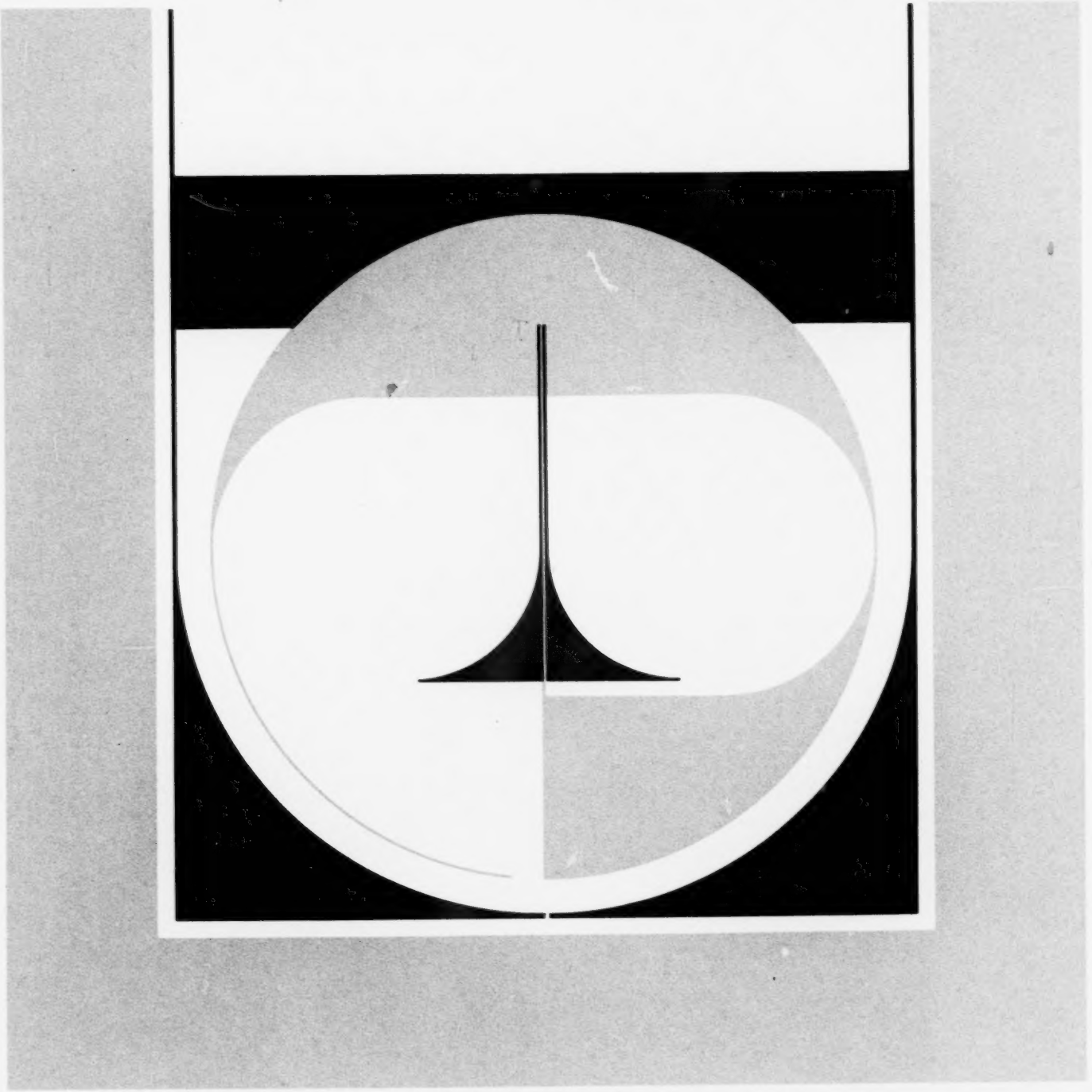

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Comparative study of secondary school building costs

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Comparative study of secondary school building costs

by

Jeoffrey Hutton and Michael Rostron
Architects

Unesco

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PREFACE

In view of the large investments that developing countries are making in secondary school construction, both from their own funds and with loans obtained from outside sources, Unesco has felt for some time that steps should be taken to help developing countries ensure that they obtained the best value for the money spent in this field. An essential first step was to undertake a study that would help Member States to compare their expenditures on educational facilities and to analyse their capital costs in the context of national resources and educational and social objectives.

The following report is a highly concentrated summary of such a study. It was sponsored by Unesco, covered 14 Unesco Member States in Africa, Asia and Latin America, and included visits to some 100 secondary schools, the bulk of which were constructed during the First Development Decade, 1960-1970.

The survey work was carried out at Unesco's request by the three Unesco-sponsored regional educational building centres: the Regional School Building Centre for Latin America (CONESCAL), Mexico City, Mexico; the Regional Educational Building Institute for Africa (REBIA) in Khartoum, Sudan; and the Asian Regional Institute for School Building Research (ARISBR) in Colombo, Ceylon. The original methodology was developed by CONESCAL although the data sheets, calculation methods and definitions of terms were mutually agreed by the three centres as well as Unesco's Department of Planning and Financing of Education. These will be found in Annexes I and II of the present report. The raw data was collected and compiled by the professional staff of the centres while an architectural firm, Hutton and Rostron, of London, United Kingdom, was charged with processing the data and drawing conclusions from the comparisons between countries, between types of schools, etc. This firm also prepared the draft on which the report is based. The views expressed therefore are not necessarily those of Unesco.

The three Unesco-supported regional centres have subsequently been able to utilize the information obtained to advise Member States on how they might obtain better cost effectiveness from their investments in educational plant.

This report has been written for educational administrators so that they may understand the value of undertaking surveys of this type as well as the importance of making the planning of educational facilities an integral part of their educational planning activities. The annexes will be of particular interest to architects, engineers and administrators responsible for the design and construction of educational buildings and will indicate methods for examining and evaluating their work. It is also hoped that agencies financing educational facilities construction will be able to apply some of the technics of this study when preparing or evaluating projects.

The report has been prepared as a part of Unesco's programme of providing information services to Member States in respect of educational buildings. This service includes the collection and redistribution of technical reports prepared by Member States as well as by the above-mentioned regional centres. However, where there is a lack of published information in certain fields, Unesco undertakes the necessary studies and distributes the results in report form. Thus, Unesco expects from time to time to publish the results of studies on physical facilities for education in this series.

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INTRODUCTION

The capital investments made in education can strongly influence - and possibly determine - the future of developing countries.

Education is frequently given such a high priority that it absorbs 25 to 30 per cent of the national budget, and it is not uncommon for a country with a rapidly expanding educational programme to divert from 15 to 25 per cent of its educational budget to construction. Thus school building construction alone might account for $3^3/4$ to $7^1/2$ per cent of the government's expenditure. This in itself demonstrates the need for stringent cost control in countries where every peso, dinar or rupee spent must somehow contribute to social and economic development.

But it is not enough simply to restrain expenditure - it is also essential to ensure that capital investments give maximum benefits. Is this substantial investment being made in buildings that will have to be rebuilt or replaced in only a few years? Is expensive physical plant being allowed to lie idle most of the time? Are the new buildings designed in such a way that they oblige the country concerned to teach groups of 30 or 40 children in self-contained classrooms for the lifetime of the buildings (which may mean 50 or 100 years)?

The data included in this report generally suggest that the work done to date should be merely the beginning of Unesco's effort to help Member States get better value out of their capital investments in education. In almost every country, secondary school space is being under-utilized. In many countries, the administrative machinery responsible for the implementation of school construction programmes was found to be so badly in need of reorganization and restaffing that the cost study was put aside to permit the investigators to give short national courses on how to improve management procedures as well as school design. It was also learned that countries with low Gross National Products per capita often spend larger amounts per student place when constructing new schools than do wealthier countries.

There were 119 topics for each of the 100 schools visited in connexion with the present study, making a total of some 11, 900 potential data items (Appendix III lists the topics and Appendix IV gives an approximate geographic description of the countries included in the study). Unfortunately, data on all 119 topics were not obtainable for every school since many Member States did not have all the information requested. The amount and nature of this unobtainable data rendered the study less illuminating than had originally been hoped. On the other hand, it is hoped that the difficulty in gathering data will have served to let Member States know the importance of keeping accurate records on future school construction projects, not to make future studies easier but to enable ministries to establish adequate cost controls for the construction of future educational plants.

A few words are in order to brief the layman and educational administrators on the technical aspects of this work and to point out the usefulness and the limitations of this study.

First, it is essential to understand that school building costs have two sources: (1) the amount of building area that is provided in relationship to the number of students using that area, and (2) the cost per square metre of building on that area. These two elements are often combined to give a cost per student. However, one conclusion drawn from this study is that while cost per pupil figures may be useful as a unit of measure for planning within a single country, they can be highly misleading for a comparative study. This is because cost per pupil figures mix two unrelated elements, one of which (cost per m^2) is highly difficult to control in developing economies. The reasons why construction prices are difficult to control include a shortage of private contractors, the inability of many Ministries of Public Works to provide accurate cost data on their projects, highly volatile prices in respect of imported materials, and occasional spurts of uncontrolled inflation in the building industry. As a consequence of these and other factors, no one has yet found, to our knowledge, a truly satisfactory way of

comparing construction costs between two countries.

On the other hand, children are largely uniform in size from one region to the next and, for better or for worse, the content and methods used in secondary education are sufficiently similar the world over to permit us to make valid comparisons between the space provided per student. Indeed the implications arising from this half of the cost formula are highly significant for developing countries. By achieving higher utilization of space built, most countries could easily increase enrolment in their secondary schools by 30 per cent. Furthermore, corridor and administrative spaces in many schools could be pared down enough to reduce by 10 to 20 per cent the surface area of the buildings in a school.

In short, we feel that some countries could reduce by as much as 50 per cent the amount of educational space required per student. On the other hand, power to lower the cost of construction per metre by more than 5 or 10 per cent is seldom in the hands of those responsible for school building programmes.

The important message of this report, therefore, concerns basic educational policies that will have repercussions throughout the educational establishment. Better utilization of school space will mean having the school building open more hours of each day. That, in turn, will necessitate raising staff work loads or requiring some teachers to come earlier or stay later than others. On the other hand, by increasing the capacity of school buildings, enrolments are increased and this in turn will oblige administrators to increase the teaching staff - and the recurrent budget - or to increase class size. Yet another policy decision that will need to be made by governments concerns utilization of the savings derived from building less space per student. Some countries might divert these savings to create an improved educational environment with more teaching aids, more generous teaching areas, furniture adapted to modern teaching methods, improved acoustical treatments for ceilings and floors, etc. Others will wish to take advantage of such savings to increase the capacity of their school system. It is evident, therefore, that educational plans cannot be drawn up without taking buildings into consideration and, similarly, school building cannot be planned without considering economic, demographic and educational developments.

FINDINGS FROM THE STUDY

The following is a summary of the findings of the study based on comparisons made between various topics included in the study. Several important graphs and charts are included to illustrate more fully the nature of the data collected. For those who wish to go more deeply into the collected data, Appendix V contains a number of graphs with comments. The reader is cautioned against regarding the median values found in the study as acceptable standards. For the most part, they should not be regarded as planning standards and we have made an effort to point out those weaknesses in present practices which appear to be flagrantly out of line with good school building policies.

PHYSICAL CHARACTERISTICS OF SCHOOLS IN DIFFERENT COUNTRIES

There are considerable differences between the countries studied in respect of geographical and climatic conditions. Natural resources in the form of materials affect the size, form and method of construction of buildings. The overall costs and effects of different building methods need further study, although the country reports show that in many countries a school building only has to serve as a simple shelter, sometimes not even internally subdivided to provide separate rooms. Generally, performance standards appear to be limited to sound control between rooms and control of daylighting levels and solar heat gain. Local materials and methods of construction are important as they will have evolved to suit the climate. Imported designs and methods often create problems, especially where lightweight structures with large window areas are substituted for heavy masonry construction.

It would seem that careful development of local techniques is required, using selected imported components and materials. The use of steel for reinforcement, beams and trusses is a good example, as in some countries the lack of timber beams of sufficient length has restricted the width of classrooms.

DESIGN AND CONSTRUCTION METHODS

Schools surveyed have been designed by architects and engineers in Europe, by government public works departments and local architects, and on the spot by local contractors. The colonial history of many countries is responsible for producing the systems now operating, as regards both education and school design. The present needs of the countries concerned do not seem to have led to significant changes in the organization of the secondary school system or the type and standard of school buildings erected.

The next decade, however, promises to bring about substantial changes in education and thus buildings of continuing value will be those which make it possible to change the size and shape of teaching areas with minimum difficulty.

This study shows how school space and cost standards, and the utilization of space and teachers, vary considerably between countries. Colonial traditions seem to be exercising too strong an influence over present school construction standards. In Africa and Asia, the lack of trained local architects and engineers in many countries may be a cause and one which will take time to remedy. In the meantime, the use of sophisticated designers and construction methods when the school building problems are really quite simple means that value for money is not always obtained.

NATIONAL POLICIES ON SECONDARY EDUCATION

The study was not intended to cover details of countries' educational policies but unless these are taken into account it is difficult to interpret the great differences in standards found by the survey teams.

Education, especially secondary education, is apparently considered "worthwhile" by the countries covered in the study since all are making

substantial efforts to increase secondary education. However, the execution of national economic development policies requires that national education policy be considered alongside investment in agriculture and industrial development. Thus, two main considerations affecting school building follow from a nation's policy for economic development, the first being the number of children to be educated and trained for particular rôles in government, industry and agriculture, and the second being the type of curricula needed.

PROPORTION RECEIVING SECONDARY EDUCATION

The proportion of the population in the age range of 12 to 18 receiving secondary education in the different countries varies from around 2 per cent to over 50 per cent. All the countries have fast-growing populations and merely to maintain the present proportions requires large and continuous school building programmes.

Cost and space standards vary greatly, suggesting that some nations are content to limit the number of extra places in new schools and maintain high building standards, while others manage to build at about one-tenth of the cost per place in order to enlarge the numbers in secondary schools as quickly as possible.

From Graph 20 (Appendix V) it can be seen that some of the poorer countries provide more generous school facilities than those with considerably greater wealth. Consequently, it seems evident that the latter have consciously or unconsciously decided as a matter of policy not to provide secondary education for a large segment of their populations. To increase secondary school enrolment substantially will require a major change in the standards of facilities required. It seems probable from this study that certain of the poorer countries could increase the proportion of the population receiving secondary education without increasing the present level of expenditures for physical plant.

In many countries, a very small proportion of girls from 12 to 18 attend school: 19 per cent in one country where 43 per cent is the complementary figure for boys. The number of children between 12 and 18 years old is increasing by about 5 to 10 per cent in most countries.

TYPES OF SCHOOL

The types of schools studied were deliberately chosen to cover the following:

General secondary:
- first cycle (entry after approximately 5 years of primary school);
- second cycle (entry after approximately 8 years of previous schooling);

teacher-training institutions requiring between six and twelve years of prior schooling for entry;

technical secondary with the following specialities: agricultural, industrial, commercial, vocational, home economics.

Considerable differences in the age of entering and leaving secondary school have been noted. The curriculum followed and hence the form of the school building will be influenced by the age of pupils. Most of the schools studied are general secondary schools, the remainder being technical secondary schools and a few teacher-training schools or colleges. Schools may or may not be co-educational. In general, the smaller and more expensive schools are for either boys or girls and are often boarding schools in rural or suburban areas; co-educational schools are usually larger day schools in urban areas.

LOCATION OF SCHOOLS

The contrast between urban and rural locations is marked and often reflects the density of population. Boarding schools are only found in countries with densities below 40 persons per km^2, 80 per cent of those studied being in suburban or rural areas. Seventy-four per cent of day schools are in urban areas.

However, a scattered or rural population does not necessitate boarding schools. Some countries build rural co-educational day schools for 300 to 500 pupils where the proportion of 12- to 18-year-olds attending school is high enough to make this feasible.

SIZE OF SCHOOLS

The schools studied have from 30 to 2, 380 enrolled pupils. The median size of schools is between 400 and 700 pupils. Technical schools tend to be larger and teacher-training schools smaller than this median but it is not possible from the survey data to relate school size to any particular type of curriculum. Twenty-five per cent of urban schools studied work two shifts, these being all in Asian countries. The median size for two-shift schools is about 1, 000 pupils per shift, only one of them having under 400 per shift.

In the African region, the median size school has about 500 pupils, in the Asian region, 700 pupils and in Latin America about 800 pupils. The Asian median is about 1, 200, if both shifts of two-shift schools are included.

CURRICULUM CONTENT

To simplify the collection of data, curriculum content was not fully covered by the national reports. Only four main categories have been

considered when examining space requirements: subjects taught in general classrooms; subjects needing special classrooms, e.g. art or craft work; sciences needing laboratories, and technical subjects needing workshops.

It is probable that the standard of the curricula in different countries varies enormously. The term "secondary education" covers all schools with pupils over the age of 12. The proportion of the national population in the 12 to 18 age group in these schools is usually small and most of them are following an academic course. From the national reports, it seems that practical work is very limited and most teaching is by formal classroom methods. Many schools have accommodation for practical work but apparently lack of equipment and materials prevents full use being made of it.

The above is substantiated by the levels of utilization of the four types of spaces. The typical academic curriculum uses general classrooms for 80 per cent of the school week (27 hours per pupil group on the average). The need for special classrooms has not been proved. In a large school this type of space can be fully used and the materials used by pupils are collected together. There is no reason why general classrooms cannot provide for all "special" subjects if some additional, possibly mobile facilities are provided. Laboratory utilization is usually low: a median figure of 18 hours (66 per cent of the average school week of 27 hours). Pupils use laboratories between 2 and 5 hours per week in most schools.

Workshops are found in technical and some general secondary schools. In the four schools where their use was recorded, workshops were used for an average of only 9 hours per week.

ADMINISTRATIVE CONTROL OF SCHOOL BUILDING

As a spin-off from the study, the investigators made a number of recommendations to governments on how to improve the administration of their school building programmes. Only in Latin America did the investigators find adequate information on materials and labour costs to ensure that costs could be estimated and detailed cost controls maintained. A number of governments were plagued with overcharging by contractors and material suppliers, contractor bankruptcy and poor workmanship.

Some of the States have building regulations which seem unsuited to schools. This seems to be particularly true of by-laws covering room height, stair sizes and means of escape. It appears that many of these standards are merely a statement of limitations imposed by traditional building forms (e.g. the absence of log timbers in one State has led to a building code which limits classroom width to 4.9 metres). What is needed instead are performance standards based on environmental, hygiene and safety considerations and taking account of the way in which modern school buildings should be used. Again, changes will come more slowly than is desirable, but it would seem essential that a large number of Member States take a serious look at their building regulations and update them to conform with modern educational techniques and modern building technology.

UTILIZATION OF RESOURCES

The ratio between the number of pupils and the number of teachers is known for all the schools studied and varies from 10:1 to 27:1. Larger schools tend to have the higher ratio but smaller schools can have from 11:1 to 25:1. The lowest number of pupils per teacher occurs in single-sex boarding schools.

Teacher contact hours are known for less than half the schools and vary from 8 to 19 hours. Teachers with the least contact hours usually work in schools with a low pupil/teacher ratio, which indicates that advantage has not been taken of smaller group sizes.

The reason given for the low working hours of teachers is that many of them are specialists and have only a limited number of groups to teach each week. The hours worked by a specialist are determined by the size of the school and the curriculum. In one country, to build schools of a fixed size around a standard national curriculum and to keep specialist teachers fully employed, would increase the specialist teacher contact hours by 40 per cent, that is from 10 to 14 hours per week.

It is probable that the number of teachers is the main determinant of the number of children who can be educated in a country. It is therefore difficult to see why teacher utilization is so low, especially in countries with few secondary schools.

Group size

Teachers are in limited supply. In theory the larger the group taught, the more children can be educated but the teacher is unable to give as much individual attention. Average group size in the schools studied varies from 28 to 42 but some groups number as many as 50 pupils. It happens that the teachers who teach the larger groups work longer hours. The strain on an individual teacher can be measured in pupil contact hours, the range found being from 220 to 760 per week.

Pupils' working week

Pupils spend from 23 to 34 hours in classrooms. The time spent in sports, reading in libraries or private study is not known. No correlation between teachers and pupils' working hours is apparent.

The school week is not known for all schools

but usually consists of six days with between 3.8 and 5.3 pupil hours per day. Even if all spaces are fully utilized during the working day the overall utilization must be considered low as compared with a potential day of 12 daylight hours.

Intensity of use of whole school

It is not possible to evaluate the overall use of a school but the use made of educational space in accordance with the time-table, including general and special classrooms, laboratories and workshops, can be measured, and ranges from under 10 hours to over 32 hours per week. The median value is 17.5 hours or under 3 hours per day. Schools showing a low figure usually have special classrooms and laboratories which are used far less than general classrooms.

Two reasons for under-utilization of educational space seem to exist. One is that classrooms are designed to take a set number of pupils even though the number in a year decreases as pupils get older. Regrouping of classes in later years can reduce under-use of the area per seat in large schools.

A second reason is that, although on the average pupils spend 80 per cent of the week in general classrooms, each class generally has its own room. If laboratories and special classrooms were used for general teaching and as class bases it could increase utilization appreciably.

Time-tabling

The demands of a curriculum can make time-tabling a difficult operation. Different numbers of pupils in each year with different types of courses, each course having options, result in the administrators demanding extra teaching spaces just to make the time-tabling easy. Logically, the reverse also seems to occur and the curriculum is restricted in order to simplify time-tabling.

The reports indicate that rooms must be provided to suit the numbers using them. If different group sizes are to be accommodated, and there is also a need for some rooms to be specially equipped as laboratories and workshops, better methods of time-tabling are needed.

A more flexible approach to special facilities seems to be needed. Special use may make a room unsuitable for other purposes but many needs can be served by having mobile equipment and furniture and by grouping simple teaching spaces around special facilities such as stores and preparation rooms.

Although not always ideal from the point of view of sound transfer, the use of large divisible rooms needs to be explored and also the teaching of several small groups in one large space.

Use of communal space

A large proportion of the area of many schools is in the form of communal space - halls, dining room, library and kitchen - and very few details of the use made of such space are available. Greater utilization can be achieved by introducing two shifts or overlapping shifts. The relationship between school and local community life was not covered in the study but a secondary school should be a social and cultural centre for an area and utilization of communal space for adult courses in the evening is also possible.

AMOUNT OF SPACE

The most detailed information obtained concerns the amount of space in schools, subdivided into different categories. Space is most easily analysed per pupil or per teacher.

The schools surveyed have from less than $2m^2$ to over $12m^2$ per pupil. A few schools with well over $12m^2$ have enrolments of far less than the stated design capacity. The smaller schools have the larger areas per pupil and tend to be single-sex boarding schools.

Different types of schools have different median values: general secondary, 4 to $5m^2$; technical 6 to $8m^2$; and teacher-training schools over $8m^2$ per pupil. Boarding schools with 6 to $8m^2$ have twice the median area per pupil available in day schools.

The total space in a school can be conveniently divided into educational (classrooms, laboratories and special classrooms) and other areas which include circulation space, communal, administrative and service space.

Educational space

Educational space per pupil, comprising general and special classrooms, laboratories and workshops, tends to be less in schools with large enrolments. The median value is between 2 and $3m^2$ per pupil enrolled with about $4m^2$ in technical schools. The range is from $1m^2$ to over $4m^2$, the total area of the school per pupil being normally about twice the educational area.

General classrooms

The area per station(1) or seat in general classrooms is an important generator of area per pupil since general classroom utilization is usually as high as 80 per cent. Area per student in each room (station area) ranges from $1m^2$ to over $2m^2$, 75 per cent having less than $1.75m^2$. The median value is about $1.5m^2$.

General classrooms are usually planned to seat 35 or 40 pupils. Studies in which the area is

(1) The term "station" is used to indicate the area per work place (or seat) while the term "place" is used to indicate the space available per enrolled pupil.

derived from desk size and arrangement were given in some reports. The body size of pupils is important, considerable variations occurring between different ages and races, so that it is unwise to give fixed standards.

The area per pupil in general classrooms (i.e. student stations actually occupied) reflects the utilization of these rooms and is found to be between 1 and 2m^2 per pupil, usually only a little less than the area per station.

Special classrooms

Over 60 per cent of the schools have special classrooms and these account for up to 1.5m^2 per pupil in the case of schools with enrolments between 200 and 400, decreasing to between 0.5m^2 and 0.25m^2 for the largest schools.

The designation of special rooms seems to go hand-in-hand with specialist teachers and one wonders if general classrooms could serve equally well providing storage and display facilities were available.

Laboratories and workshops

The provision of laboratories for science teaching and workshops for technical subjects is justified provided the curriculum allows pupils to engage in practical work. However, if science is taught by demonstration, the large area per station, i.e. a median between 2 and 3m^2, is wasteful. General classrooms could be planned with science bays and mobile benches.

Laboratory space accounts for areas between 0.2 and 1.5m^2 per pupil enrolled, again the smaller schools having the larger areas. It is notable that some countries have several schools without laboratories.

Few schools studied have workshops, but where they do exist the area per place is from 0.2 to 2m^2, and station area from 1.5 to over 9m^2.

With such large station areas, it is necessary to design workshops around their particular function and to make them as adaptable as possible to allow full utilization.

Circulation space

Circulation space is necessary only to link useful spaces. Judging by the survey data it appears to be difficult to control. Some single-storey schools manage without any circulation area by having direct access from classrooms to outside. Other schools have up to 2m^2 per pupil.

Circulation areas of up to 45 per cent of the total area were recorded in some schools. This is an extremely high proportion and even the median of 27 per cent is excessive for this marginal function. School designers should make every possible effort to reduce circulation areas to less than 20 per cent and, at the same time to plan circulation areas so that they can be used for other functions such as classroom overflow, project areas for small groups, project display, etc.

Communal, administrative and service space

The survey shows great variations in space standards for these functions. Some schools have large assembly halls with a greater area per pupil than is found in many whole schools. The greater area per pupil normally found in small schools is often due to the inclusion of these types of space.

Dining rooms account for large amounts of communal space which could be used more effectively if students were seated in shifts or if a cafeteria service were used.

SCHOOL SITING

Form of buildings

Schools studied are up to four storeys high. Small schools and rural schools tend to be single-storey structures: three- and four-storey buildings generally occur only in densely populated urban areas. Two-storey buildings seem uneconomic since they do not conserve much land as compared with single-storey buildings, need more circulation space and tend to cost more per m^2 to build.

Many schools are built with separate blocks serving different functions. This allows phased building to take place. Careful siting can ensure sheltered spaces between buildings and adequate facilities for ventilation. Single-sided open-access balconies are commonly found in multi-storey schools. These are often responsible for the large circulation areas already noted. If more compact designs with rooms on both sides of the corridors are proposed they need to be carefully considered to make sure thermal performance is not sacrificed.

Site area

Site area per pupil varies for 53 schools studied from 4 to 4,000m^2. The median figure is 30m^2 per pupil but the extent of sports area included is not known. Single-storey and two-storey schools have median areas of about 60m^2, three-storey schools have about 25m^2 and four-storey about 15m^2 per pupil. These figures reflect the pressure on land in the neighbourhood of the schools in question.

LIVING ACCOMMODATION

Thirty-three of the schools surveyed have boarding accommodation. The number of boarders is

not always known, so the area per pupil may not reflect the amount of space allocated to one pupil. Staff houses are often provided and can form about 4 to 14m^2 per pupil, some correlation being found between day school area and living area. The total school area for boarding schools is from about 9 to 27m^2 per pupil in comparison to day schools with a median area of between 3 and 4m^2.

COST

Survey teams had great difficulty in obtaining cost information. Records were often not available or scattered amongst several government departments. Although the methodology allows for cost-of-living indices to be applied, these were not available and all costs are expressed in US dollars using current exchange rates. One case study of total cost (including recurrent as well as capital costs) was produced and will be found at the end of this chapter.

Cost per pupil

The net cost per pupil is found to vary from about $50 to $2,100, the median value being $250 per pupil. A comparison with GNP per capita in every country shows cost per pupil to be approximately equal to 50 per cent of the GNP figure. Schools in countries with GNP per capita of less than $100 tend to have much higher costs per place, the median figure being $350. This may be because secondary education is limited in these countries and schools are prestige buildings.

Regional differences are significant: the African median is about $350 per pupil, the Asian median is about $120 and the Latin American about $240.

Type of school

The median cost of technical secondary schools is $400 per pupil, almost twice as much as the median cost of general secondary schools. Co-educational schools have a median cost per pupil of about $120 which contrasts with a figure of $350 for boys' or girls' schools.

Boarding schools have a median cost of over $500 per pupil for day school space.

Cost per pupil and size of school

Cost per pupil tends to be less in schools with a larger enrolment, although schools throughout the whole size range have been built for under $100 per pupil. The median values found are:

Number of pupils	Cost per pupil
	$
200	460
600	290
1,000	200
1,800	100
2,200	70

Cost per m^2

The cost range for schools studied is from $22.6 to $197 per m^2. This is partially a reflection of varying standards, the lowest cost schools being open-hall shelters with low exterior walls and few or no interior partitions, while the most expensive schools are liable to be of reinforced concrete frame construction, fully glazed and partially air-conditioned. The range also reflects the substantial economic differences between countries - a dollar buys a lot more in some countries than in others though it was not possible to quantify this difference. The surprising result of the comparison of costs per m^2, however, is that schools which have comparatively high costs per m^2 also have relatively high areas per student. Herein lies the explanation of the staggering 4,000 per cent variation in cost per pupil noted above ($50 to $2,100).

THE MEDIAN SCHOOL

The data below indicates the range of values found for the main topics and the median value for each. These median values are not put forward as acceptable standards but they are useful as indications of how a particular school compares with the survey sample.

	Topic	Range of values			
		Lowest	Highest	Median	
9	Number of enrolled pupils	30	2,380	700	
12	Pupil/teacher ratio	10:1	27:1	20:1	
45	Pupils/group	28	42	36	
65	Hours/group	23	34	27	
66	Hours/teacher	8	19	15	
	Area: pupil m^2				
16	net	1:4	38	6.0	100%

	Topic	Range of values			
		Lowest	Highest	Median	
23	educational	1	12	2.6	44%
24	communal	0	12	0.8)	
25	administration	0	3	0.4)	33%
26	service	0	4	0.8)	
27	circulation	0	6	1.4	24%
19	general classrooms	0.9	5	1.5	
20	special classrooms	0	2	0.4	
21	laboratories	0	1.6	0.7	
22	workshops	0	6	0	
Area:	station m^2				
33	general classrooms	1	2.9	1.5	
34	special classrooms	1.5	4.8	2.1	
35	laboratories	1	5	3.0	
Hours/group					
67	general classrooms	15	29	20	
68	special classrooms	0	8.7	3.5	
69	laboratories	0	8	3.9	
79	Cost: pupil $	49	2,100	250	
85	Cost: m^2 $	22.6	197	50	

The utilization of the educational area of the composite median school has been calculated at 18.9 hours per week.

TOTAL LIFE COST STUDY

Information on capital and running costs has been produced by REBIA for one school, a boarding school for 320 girls. The following analysis demonstrates the importance of considering all costs, especially staff costs, before taking decisions on building design. Staff costs have been estimated by the consultants to complete the information given. Even without these, the comparisons between initial and recurrent costs are significant.

The life of the buildings is assumed to be 50 years. The capital cost of the building and its initial equipment and furnishing have been estimated at 5 per cent over the 50-year period, to produce annual equivalent sums to compare with normal recurrent costs and the occasional costs of alterations. Costs are expressed in US dollars per pupil per annum.

Total cost analysis for whole school

Description	Cost/pupil	Percentage
Initial costs (capital cost equivalents)	$	
Land (no figure given: owned by government)		
Building (1963-1965 contract)	67	25.0
Furniture (day school and boarding)	9	3.4
Equipment (in laboratories)	2	0.4
Total initial costs	78	29.1

Description	Cost/pupil	Percentage
Recurrent costs (building)	$	
Running cost	45	16.8
Maintenance	31	11.6
Adaptation	1	0.4
Maintenance of furniture and equipment	2	0.7
Total recurrent costs	79	29.5
Staff costs (estimated)		
Teaching staff (1: 11 pupils)	87	32.4
Administrative staff (1: 80 pupils)	12	4.5
Service staff (1: 17 pupils)	12	4.5
Total staff costs	111	41.4
Total annual cost per pupil	268	100.0

Total area per pupil for living and day areas 19.54 m^2.

Total cost analysis for day school and living areas

A crude estimate of the division of total cost into day school and living (boarding accommodation) areas is possible. A common cost per m^2 has been assumed for the building. The split of furniture and equipment cost is known and recurrent running and maintenance costs have been divided in proportion to area of buildings.

Description	Cost/pupil	
	Day school	Living accommodation
Initial costs	$	$
Building	24	43
Furniture	3	6
Equipment	2	-
Total initial costs	29	49
Recurrent costs		
Running cost	16	29
Maintenance	11	20
Adaptation) Maintenance of furniture)	1	2
Total recurrent costs	28	51

Description	Cost/pupil	
	Day school	Living accommodation
	$	$
Staff costs (estimated)		
Teaching staff	87	-
Administrative staff	8	4
Service staff	4	8
Total staff costs	99	12
Total annual cost per pupil	156	112
Area per pupil	6.85m^2	12.68m^2

Cost of site

This school has a site area of 416m^2 per pupil. Although the land is owned by the government, it is likely to be valued at about $0.25 per m^2. The capital cost per pupil is therefore $54 which is equivalent to $3 per annum when amortized at 5 per cent over 50 years. Three dollars is equal to 12.5 per cent of the building cost, or the whole cost of furniture.

Cost of design

No information on design cost for this school is available but is probably equal to about 8 per cent of the building cost or $2 per pupil for day school space and $4 per pupil for living accommodation, a total of $6.

The relationship between design decisions and subsequent recurrent costs will be appreciated. The comparable costs are $6 for design, and $76 per annum for recurrent cost. A greater and therefore more costly design effort may result in larger savings in recurrent costs. The high maintenance cost in relation to building cost should be noted. The amount and cost of maintenance needs to be given consideration at the design stage.

UTILIZATION

The day school space in this school is in use for an average of 16.6 hours per week. Doubling the utilization would have the effect of halving the initial cost per pupil but recurrent and staff costs would remain the same (assuming the same pupil/teacher ratio as before). Initial cost would therefore be reduced from 18.6 to 9.3 per cent of total cost. Gains may not be as dramatic as the amount of increased utilization would suggest.

CONCLUSIONS

One isolated example cannot be used as a guide to future cost planning of school buildings. It should be noted that this is a fairly expensive building, ($430 per pupil in day school space built for $63 per m^2) compared with the whole range of schools studied, but as a 300-pupil boarding school it is close to median values.

The value of this example is in the demonstration of the relative weight of the different cost items. The school has a very favourable pupil/teacher ratio of 11. Even if the number of teachers was halved, the staff costs for day school space would be over twice those for the amortized building and slightly less than twice for the recurrent costs. In other words, if the staff numbers were halved, the money released could provide, run and maintain a day school equivalent in size to the one under examination.

The cost of provision of boarding accommodation is also well illustrated. Here it is equivalent to the total cost (initial, recurrent and staff costs) of an identical day school with a pupil/teacher ratio of 22.

MAJOR CONCLUSIONS AND RECOMMENDATIONS TO MEMBER STATES

EDUCATIONAL POLICY

Few of the countries studied have a clear secondary education policy on numbers of pupils, curriculum standards and teacher training, coupled with a planned programme of school building. There is a need, therefore, to develop rational bases for the location, size and form of schools, in the light of the economic state of the country concerned and its future manpower requirements. Demographic factors have a strong influence in these matters and hence on cost per pupil. If boarding schools are considered necessary because of a scattered population, the cost per pupil will be substantially greater than for day schools. Secondary schools need to be seen as part of the whole education system and planned in relation to primary schools and higher education facilities, and the social and cultural requirements of local communities.

An adaptable educational policy model is needed to assist in forming school building programmes. It should take account of all national differences. An outline for integrating the planning of educational buildings into national educational planning practices is given in the following chapter.

POPULATION GROWTH

For all the countries studied, a continuous school building programme is needed merely to keep pace with an increasing population. If a country's aim is to increase as quickly as possible the proportion of the 12- to 18-year old age group receiving secondary education, there are two main shortages to be overcome - of teachers and of space. The supply of teachers is a matter of suitable selection and training, which takes time; buildings cost money.

For the economic control of a school building programme, overall costing and planning methods are required. It is necessary to examine the cost of education per pupil against the quality of facilities required. How far can standards be lowered to enable more pupils to benefit? What are the minimum acceptable shelter standards for a school, taking into account educational aims and climate? The lowest standards found could easily halve the cost per place of schools in many countries.

On the other hand, the education to be given to this expanding population should be of adequate quality. This will require a suitable physical environment which in most countries needs considerable improvement. Classrooms and laboratories are too narrow and too cramped, chalkboards are inadequate while tackboards are almost unknown; the provision of electricity would enable the use of projectors and television receivers.

BUILDING SPACE AND COST

In terms of space per pupil in a school, it seems that an educational programme can be made to function in any area from 2 to 12m^2.

The overall use of school space is most significantly measured in hours per week, a range of 13 to 26 hours being found in single-shift schools. It is difficult to believe that a school with 12m^2 per pupil, costing $1,000 per pupil, in which educational space is used only 13 hours a week, can be built in a country of the same economic level as another where schools have only 2m^2 per pupil costing $70. This is the case, however, although it should be noted that the first school is likely to be a small rural boarding school and the second a suburban or urban day school. It is likely that the national differences found in space and cost are much wider than differences in educational policy, curricula and teaching methods.

Countries which have high per pupil costs and low GNP per capita should undertake a vigorous reappraisal of their national objectives to determine whether or not secondary schools should be luxury or prestige institutions, which appears to be the case at present.

In any event, it is clear that small schools are more expensive than large schools and boarding

schools are two or three times as expensive as day schools. The implied conclusion is that boarding schools, if they are required, should be relatively large. In urban areas, governments should strive to establish day schools, even if they have relatively low enrolments.

Conversely, countries which are relatively wealthy and where per pupil costs are at present low may well be able to afford to upgrade the physical environment of their schools.

For all countries, realistic minimum school building space standards and maximum cost limits need to be updated and administrative controls established to ensure that these are adhered to.

TOTAL COST OF EDUCATION

Information is required on the total cost of education: capital and running costs, salaries, the cost of building maintenance and adaptation must all be considered on a common basis, that is, by discounting capital sums to find equivalent annual amounts. Total cost information can have a bearing on school size and location. It seems likely that the total cost per pupil is less in large schools where space (and specialist teachers) can be more fully utilized but capital costs may be higher. A large multi-storey school is likely to be more expensive per m^2 than a small single-storey one. As teachers' salaries comprise the largest single sum, teacher utilization, teaching methods and equipment need to be carefully studied before setting building standards.

TEACHERS' WORKING WEEK

The availability of teachers is the key to any educational programme. Some countries have managed to run schools without buildings but none without teachers. Two separate factors determine the usefulness of a teacher: his working week in terms of contact hours and the size of the group or class he teaches. Teacher contact hours were found to be generally between 8 and 19 hours per week and groups taught have between 28 and 40 pupils. A teacher can therefore teach as few as 220 pupil contact hours per week or as many as 760. As noted earlier, the total number of pupil contact hours is a measure of the strain on a teacher. How many are acceptable? Many schools enrolments could be expanded if group size and teacher contact hours were increased or alternatively, running costs could be reduced or more money made available for books and equipment.

SPECIALIST TEACHERS

Teacher specialization and curriculum demands have a strong bearing on teacher contact hours and school size. A science teacher may teach all three main divisions of the subject or specialize in just one, such as physics. As the curriculum may set only a few hours a week aside for science, the teacher works relatively few hours himself unless the school is large enough (probably over 800 pupils) to provide a time-tabled class several times a day. In smaller schools, specialist teachers might be trained to teach subjects outside their particular field.

FRAMEWORK FOR SCHOOL PLANNING

The study demonstrates the need for rational school planning methods, capable of taking account of all the different requirements to be found in educational and architectural briefs. The framework should extend from the initial planning of an educational programme, having regard to the country's present educational resources, to the detailed design of a particular building, its costing and cost control during construction and subsequent operation.

It is not possible to achieve a fully workable method without a trial-and-error process. At this stage, it is better to have a crude framework than, for instance, a finely detailed cost analysis method but no clear way of deciding size and location of schools.

CHOICE OF SITE

The size of school sites, measured in m^2 per pupil, varies greatly but usually reflects the density of surrounding development. The arrangement of buildings often hinders future extension. Site cost should be related to all other costs in arriving at a choice of site. The site may have been given free but this fact must not prevent a realistic assessment of its value.

HEIGHT AND DENSITY OF BUILDING

Height and arrangement of buildings seems to be a direct consequence of the choice of site. Factors influencing siting were not covered by the studies. Most rural and suburban schools are single-storey structures: three- and four-storey buildings occur in dense urban situations. Single-storey buildings are simpler, can be easily extended and can be cheaper per m^2 than two- or three-storey ones. They need only have a small amount of circulation area, giving a lower overall cost per pupil. It appears that site area and the advantages of single-storey development are not always fully considered. Since site cost is likely to be under 1 per cent of annual total cost (initial, recurrent and staff costs) the purchase of a large site will require only a marginal annual expense but will offer considerable long-range returns in the form of sport fields,

open urban space, and area for future school expansion.

BUILDING EXTENSION

The study covered buildings which were mostly erected in the last ten years. Building extensions were not studied. However, since the need to enlarge and adapt schools is ever-present, sites must be large enough to allow reasonable change. Where possible, buildings should be designed to permit, or at least not to hinder, change. This need not mean extra building cost. Simple buildings and unspecialized spaces are the most adaptable to future changes and are, therefore, a hallmark of good school design.

BUILDING STANDARDS AND COST CONTROL

It will prove very difficult to establish universal building standards when constructional methods rely on local materials and labour. Methods of estimating building cost need to be established, in line with the abilities of local administrators, designers and contractors. Only crude cost breakdowns will be needed until all parties are skilled in their use and convinced of the need for more accurate methods. It is very important for them to record data on projects in progress. A simple control and record system should be set up as soon as possible in Member States where controls do not exist.

BUILDING SIZE

The survey shows great variation in space standards, some of which can be explained by the fact that they relate to different types of school. Overall space per pupil is the result of decisions on curriculum and time-tabling coupled with an area per station in different types of room. Some consistency in area per station has been found but the use of space shows a wide range of standards. A method for deriving overall building size from curriculum content is needed, producing a target area within which the different types of space can be planned and aspects of time-tabling and utilization studied.

ROOM SIZES

Two problems have been found concerning the size of classrooms. Most schools seem to have uniform teaching spaces designed around fixed class sizes, normally 40 pupils. But pupils progressively leave the schools before completing the whole course and, in later grades, these smaller numbers may be regrouped to fill classrooms. The other problem is that where a curriculum allows for elective subjects, the group sizes are often smaller than the normal class and consequently rooms are only partly used.

The provision of a range of room sizes needs to be examined when a new school is being planned and consideration should be given to methods of dividing large rooms.

CIRCULATION SPACE

The studies found the circulation area in schools to be from nil to over 50 per cent of total day school area. The circulation space is excessive in many schools since optimal target areas for circulation space would be around 15 per cent in single-storey schools and 20 per cent in multi-storey buildings. Circulation space may have other uses, i.e. for recreation and overflow classes, but these uses need to be specified and space allocated if they are legitimate.

INTENSITY OF USE

There is a danger that the intensive use of space could become an end in itself. However, the most intensively used school studied was in use for 33 hours per week, the median figure being 17.5 hours. Considering that a six-day week has 72 daylight hours, it hardly seems appropriate to say that the space in any of the 100 schools is intensively used! What target is realistic? The total cost exercise (previous chapter) shows furnished and equipped 'space' as about 19 per cent of annual cost and, on the other hand, it has been found that for the median school, some 44 per cent of the total area of the school is teaching area. Thus, each ten per cent increase in the number of hours during which teaching space is used would reduce total annual costs by only 2 per cent.

However, the amount of use is sufficiently low in many schools to allow large increases in the number of pupils if the working day is lengthened and an overlapping time-table developed. On the other hand, savings from increased utilization of new schools might be diverted into improved surroundings or additional equipment (in the total cost example, a 20 per cent increase in utilization could double the furniture and equipment budget). Communal space, halls and dining rooms usually have spare capacity. The sociological as well as economic consequences of this kind of scheduling need to be carefully worked out. Only if there are visible benefits from the changed schedule - such as receiving more and better teaching aids - will teachers and parents accept to change their daily routines.

COMMUNITY USE OF SCHOOLS

It was not possible to determine the extent to which local communities use school space and facilities.

A secondary school has a good potential for community use and there is no reason why this should not be considered at design stage. It would seem that because secondary education is often open to only a small percentage of the population, the schools are similarly reserved. Possible use for adult education should not be ignored.

LABORATORIES AND SPECIAL CLASSROOMS

Most schools have science laboratories and special classrooms for certain subjects, such as art or geography. Most curricula allow only a few hours per week for these subjects and consequently only limited use is made of these spaces. Larger schools achieve up to about 20 hours' use per week. It is likely that most of this type of teaching could take place in general classrooms or in a few multi-use rooms. There seems to be a tendency to give special names to rooms with the same type of use as general classrooms. A tighter control of space could allow more money to be spent on equipment for special subjects.

DESIGN METHODS

The design methods and skills used to produce the schools studied varies from simply erecting a shelter using locally available material in a traditional form to a full professional design and cost service. It is unnecessary and unfair to make comparisons but in both cases some form of design guidance is vital. Such guidance must be suited to local conditions. It seems that there is a need for typical plans of elementary structural systems which can stimulate local action. These structures must provide buildings adapted to the local climate, materials and skills and to present and possible future teaching techniques. Live experimental projects would provide the best conditions for their development.

CHANGES IN SCHOOL USE

It is difficult to see what form change will take. Greater use of buildings is likely where the population is within easy travelling distance and makes demands on school places. More emphasis will be put on scientific and technical subjects and this, coupled with the need to have more equipment, will mean more care in budgeting. Space may be reduced to allow for better fitting out of buildings. Teaching methods will bring about changes in group sizes and will generally move towards giving each individual student greater freedom to choose a curriculum suited to his needs and abilities. Increased evening use will necessitate better electric lighting and possibly heating and ventilation in some countries.

Countries with a scattered population face a difficult problem. Boarding schools will be required until secondary education can be provided for a sufficient proportion of the 12- to 18-year-old group to allow for day schools serving a practical catchment area. It should be noted that it may cost twice as much to educate a child in a boarding school as in a day school.

In countries with growing urban areas, boarding schools will gradually be phased out in favour of day schools which will cope with increasing enrolment rates in urban areas. Thus new boarding facilities should be designed so as to permit their future conversion for use as classrooms or for other purposes.

PLANNING AN EDUCATIONAL BUILDING PROGRAMME

EDUCATIONAL POLICY

A country's educational policy is the generator of its school building programme and exercises a strong influence on the design of individual schools.

This study has examined actual school buildings. The educational policy and form of administrative organization that generated these schools has not been specifically documented by the investigators.

This section suggests a sequential framework for educational planning and the briefing of school architects, based on a logical ordering of decisions related to national demographic, geographic and social factors.

INFLUENCES ON EDUCATIONAL POLICY AND SCHOOL BUILDING

Diagram 1 shows the complex relationship of influences on educational policy and school construction.

Thc size of the population, and the location of towns and cities, are prime factors in national economic and educational planning. Geographical factors, natural resources and climate affect industrial and agricultural development, on which the living standards of a country usually depend. The possible expansion of industry and agriculture is the common basis of economic policy-making. Future manpower requirements can be predicted and these in turn create educational demands.

Social, political, and cultural factors, including religion, language and class structure, are powerful influences on educational policy, often creating separate education systems.

TEACHERS

The number of teachers is the most critical factor in planning an education programme. A teacher's working week and the number of children taught in a group combine with the number of teachers to give the total number of pupils that can be taught at one time. Teacher training is an essential part of any manpower plan.

CURRICULUM

If overall standards for school planning are to be used, some form of national curriculum is needed. This need not imply a lack of choice for individual schools, or even individual pupils, but the financial consequences of such choices must be realized at the programming stage.

An educational policy based on economic growth and manpower planning will indicate the number of pupils needing education up to different levels and learning different skills. Curriculum content and teaching methods are major influences on the amount and type of space required to teach a pupil and must be considered when establishing an educational policy.

COST OF EDUCATION

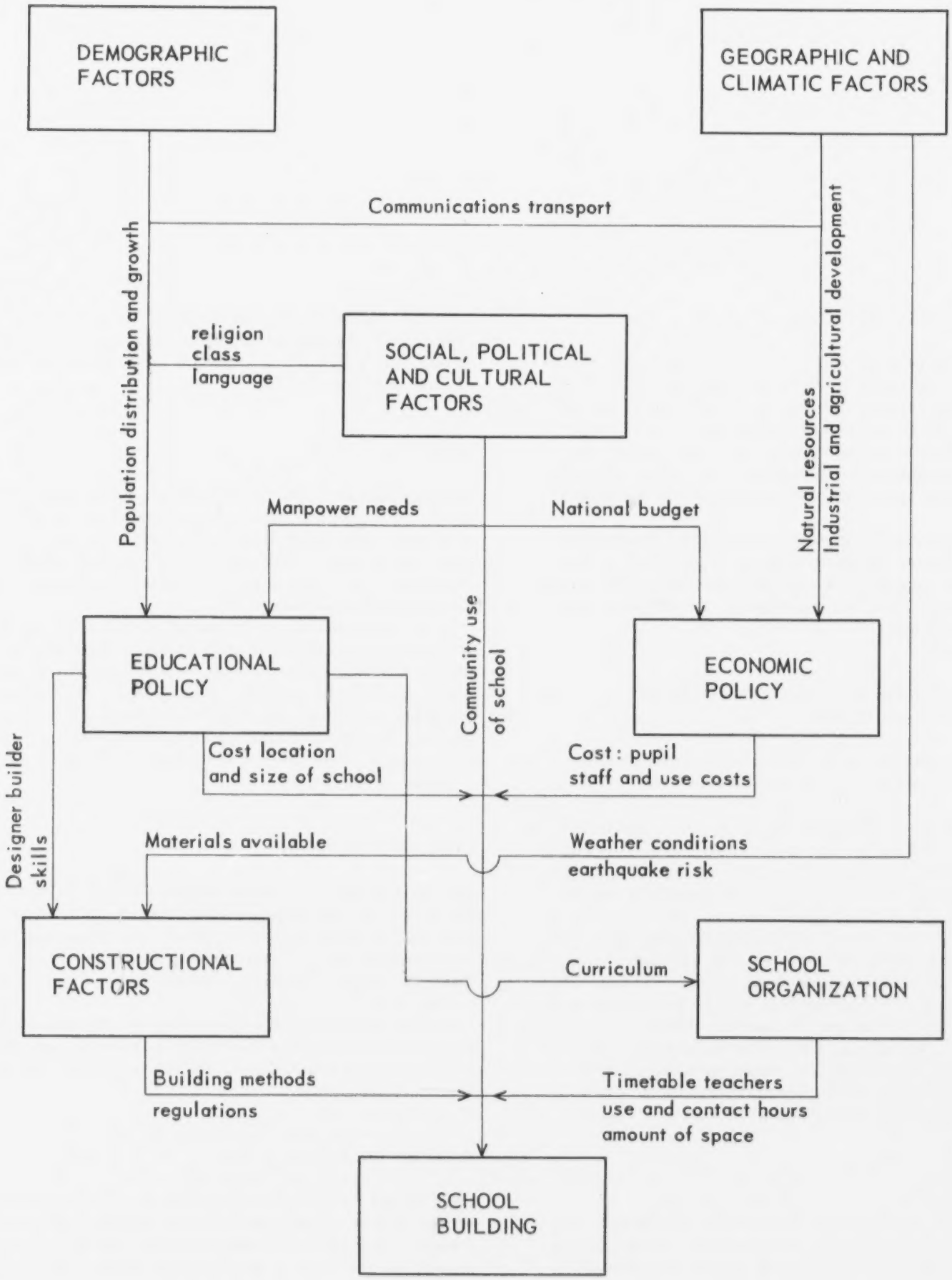
National economic policy can be used to derive the level of cost which is feasible for the education of one pupil. This total cost must cover the capital cost of schools and their equipment as well as recurrent costs: running, maintenance and staff costs.

The overall figures relating to a national educational policy would therefore cover the number of pupils, the type of curriculum and total cost allowance per pupil.

SURVEY OF RESOURCES

Data on all schools in a country should be collected before a new school building programme is established. For an initial programme, data collection should be a simple and speedy process covering

DIAGRAM I - INFLUENCES ON SCHOOL BUILDING



type of school, catchment area, and number of pupils together with an estimate of the extra pupils who could be accommodated by increased utilization of existing space, especially common facilities such as communal space, dining room and kitchen, and by simple building additions. Estimates of the cost per pupil for these additional buildings must be made and details of recurrent costs, running, maintenance and staff costs will be required.

The resources for the production of new buildings need to be assessed. The cost per m^2 for different types of construction should be estimated for different regions of the country, taking note of local methods and materials, climate and terrain. The cost of a standard school plan or structure could be estimated.

In addition, this information will indicate the number of pupils that can be accommodated in present school buildings, provided that standards for pupils' and teachers' working weeks are fixed and targets established for station and room utilization.

The aim should be to maximize the use of present facilities by adding sufficient additional accommodation to balance that which now exists, thus giving good overall utilization, and to evolve a complementary programme of new school building.

BUILDING PROGRAMME AND COST PER PUPIL

The total national budget for education can be considered in three parts:

1. Recurrent cost for existing schools.
2. Total cost of additional places in existing schools.
3. Total cost of places in new schools.

The survey of resources gives information on Parts 1 and 2. Part 3 will indicate the target total cost per new school place. A decision on the subdivision of total annual cost per pupil needs to be made, based on the experience of the resources survey. This will give a target capital cost per pupil for school building.

TYPES OF SCHOOL

Each country needs to be clear as to the types and sizes of school best suited to its educational policy.

A significant difference in educational aims and standards between countries with scattered populations and those with more dense urban populations has been observed. A lack of population centres able to support day schools has led to several countries adopting a system of boarding schools, often located in rural areas and usually segregated. As well as living accommodation for pupils, housing for teaching staff is more often than not provided. These schools tend to have a greater day school area per place than corresponding day schools and therefore the total cost per pupil, when living area is included, is considerably more.

The choice of school location and the size of the catchment area must be studied in combination with school size which in turn is influenced by curriculum considerations.

Nomogram 2 enables the size of a school and the possible catchment area to be compared. At this stage it is important to examine the effects of different school sizes and distribution on:

1. The need for boarding schools, which can result from catchment areas being too great to allow easy daily travel. The distances travelled, the time taken and the method of transport must be compared to the higher costs, lower utilization and social advantages and disadvantages of boarding schools. The provision of school buses may be far cheaper than providing boarding school places and also allow greater utilization of school space by overlapping shifts.
2. The need for single-sex schools which require larger catchment areas than comparable co-educational schools.
3. The curricula which can be followed, in light of the fact that larger schools are more able to utilize specialist teachers and specialist space.
4. The future needs of secondary schools. As secondary education becomes possible for a higher proportion of the population, more schools will be needed. A larger number of small schools offers a better potential for growth than a smaller number of large ones.

ORGANIZATION OF SCHOOLS

Having arrived at the optimum enrolment for a particular school relative to its catchment area and once standards are set for teacher contact hours and curriculum hours per group, it is possible to consider the organization of the school in terms of the number and size of teaching groups.

Nomogram 3 shows how these topics are related.

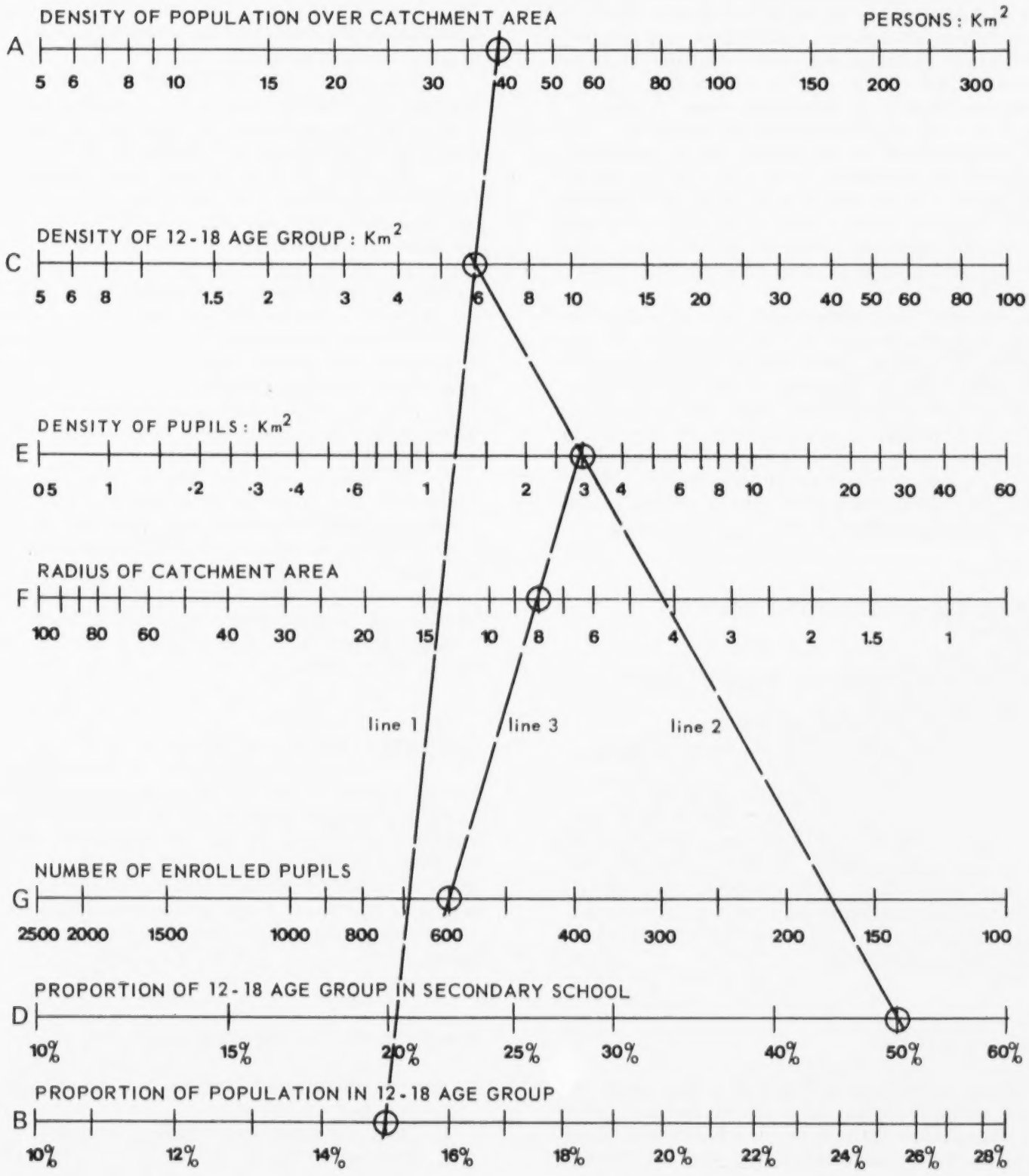
AMOUNT OF ACCOMMODATION

So far the educational model will have indicated:

1. Number of pupils.
2. Hours of study for different subjects.
3. Number of teachers and their contact hours.
4. Division of school into "years" and groups.
5. Target cost per pupil.

These factors, together with the curriculum and the options open to individuals and groups, are the generators of the list of educational spaces required (schedule of accommodation). The curriculum must be analysed to establish the different types of accommodation needed.

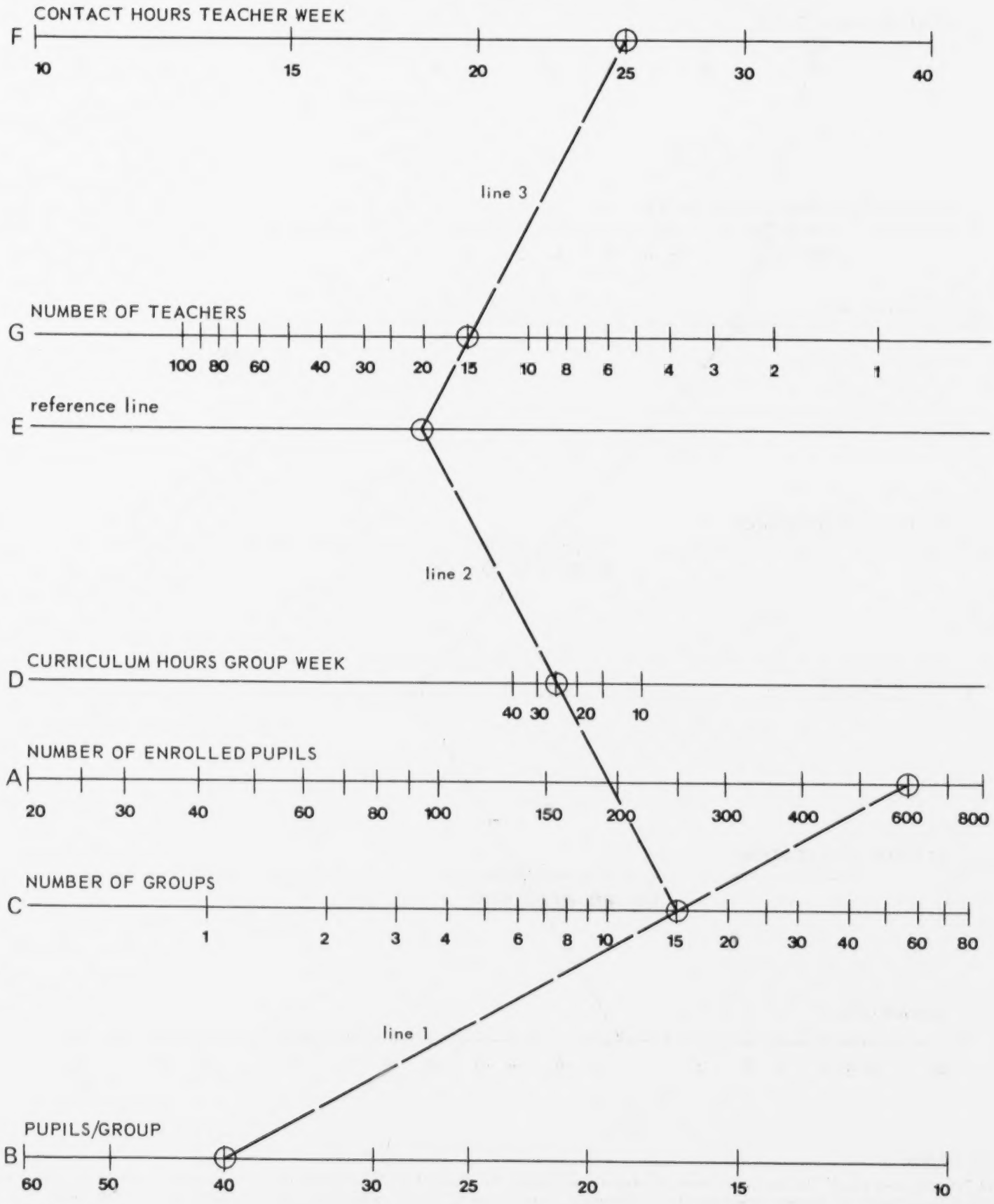
NOMOGRAM 2 - RELATING SCHOOL ENROLMENT AND DENSITY OF POPULATION


DENSITY OF POPULATION OVER CATCHMENT AREA
PERSONS : Km²
A
5 6 8 10 15 20 30 40 50 60 80 100 150 200 300
DENSITY OF 12-18 AGE GROUP : Km²
C
5 6 8 1.5 2 3 4 6 8 10 15 20 30 40 50 60 80 100
DENSITY OF PUPILS : Km²
E
05 1 ·2 ·3 ·4 ·6 1 2 3 4 6 8 10 20 30 40 60
RADIUS OF CATCHMENT AREA
F
100 80 60 40 30 20 15 10 8 6 4 3 2 1.5 1
line 1
line 3
line 2
NUMBER OF ENROLLED PUPILS
G
2500 2000 1500 1000 800 600 400 300 200 150 100
PROPORTION OF 12-18 AGE GROUP IN SECONDARY SCHOOL
D
10% 15% 20% 25% 30% 40% 50% 60%
PROPORTION OF POPULATION IN 12-18 AGE GROUP
B
10% 12% 14% 16% 18% 20% 22% 24% 26% 28%

METHOD OF USE

1. Join "density of population" on Scale A to "proportion of population in 12-18 age group" on Scale B. Example: line 1 40: km² joined to 15 %.
2. Join point where line 1 intersects Scale C to "proportion of 12-18 age group in secondary school" on Scale D. Example: line 2 joined to 50%.
3. Join point where line 2 intersects Scale E to "radius of catchment area" on Scale F and extend line to cut "number of enrolled pupils" on Scale G. Example: line 3 joined 8 km on Scale F and extended to Scale G. In a catchment area of 8 km radius a school for 600 pupils will be required.

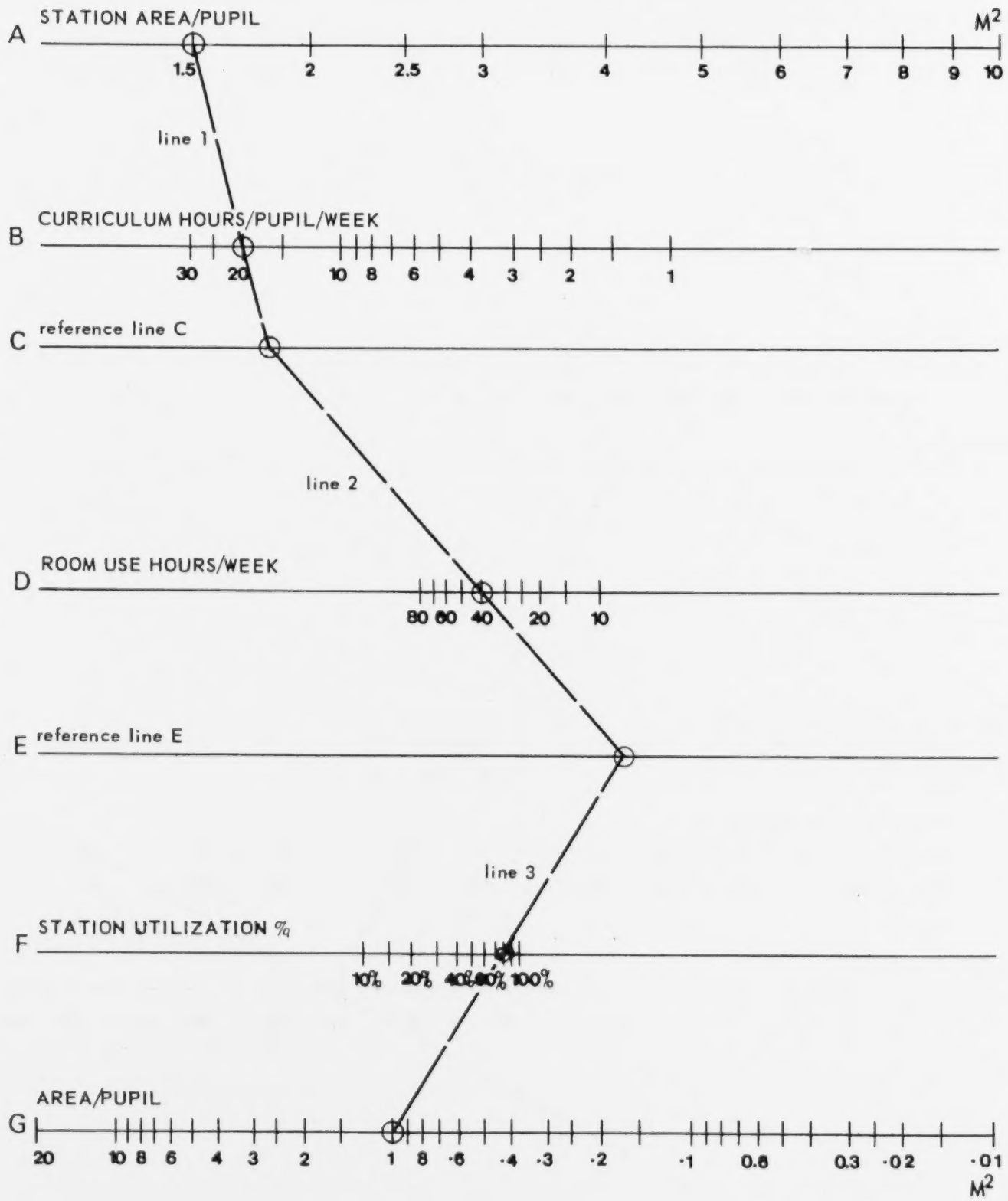
NOMOGRAM 3 - RELATING CURRICULUM AND CONTACT HOURS



METHOD OF USE

1. Join "number of enrolled pupils" on Scale A to "pupils : group" on Scale B. Example : line 1 shows 600 joined to 40 giving "number of groups" on Scale C as 15.
2. Join "number of groups" on Scale C to "curriculum hours/group/week" on Scale D and extend line to meet reference line E. Example : line 2 shows 15 groups joined to 30 hours : week.
3. Join point found on reference line E to "contact hours/teacher/week" on Scale F. Number of teachers required is given where line 3 cuts Scale G. Example : line 3 shows teacher hours as 25 on Scale F indicating that 15 teachers are required.

NOMOGRAM 4 - RELATING UTILIZATION AND AREA/PUPIL



METHOD OF USE

1. Join "station area/pupil" (for particular type of educational space) "on Scale A to "curriculum hours/pupil/week" (in type of space) on Scale B and extend line to meet reference line C. Example: line 1 joining 1.5 m^2 to 20 hours/week for general classroom use.
2. Join point found on line C through "room use hours /week" on Scale D to meet reference line E. Example: line 2 passes through 40 hours /week.
3. Join point found on line E through " station utilization %" on Scale F to meet Scale G. Area: pupil is given by Scale G. Example: line 3 passes through 80% station utilization (1e average group size of 32 in a room for 40) to show that area per pupil for general classroom space is 1 m^2. 1 m^2 is 2/3 of station area per pupil indicating total number of general class stations is 2/3 of enrolment.

AMOUNT AND USE OF SPACE

No figures for amount of space in the different categories of educational area can be found until standards of utilization are set. These will probably vary, laboratories and workshops being used for fewer hours than classrooms to allow for preparation and cleaning.

The school's total accommodation needs can be expressed as m^2/hours if area per station standards are assumed and multiplied by total pupil/hours for the different parts of the curriculum. The actual amount of space required for educational purposes is found by dividing total m^2/hours by the number of hours that the space can be used in a week. A factor for station utilization is also applied. This calculation should be made for each type of educational space. Nomogram 4 shows how different utilization standards affect area per pupil in a school.

TOTAL SCHOOL AREA

The schedule of accommodation for the whole school will consist of educational space, calculated as above, and allowances for administration space based on number of teachers, and for service area and communal area based on number of pupils. Circulation space will be an additional percentage of the total scheduled area.

Appendix VI gives a method for arriving at the number of teaching spaces needed in a particular school. This, coupled with nationally derived space standards, will enable Member States to programme building requirements for specific projects.

ADDITIONAL INFORMATION

The items above will enable authorities to prepare a brief for school designers which will give areas per pupil, number of teaching rooms and maximum cost per pupil.

However, an architect should also be given detailed advice on how and by whom individual spaces will be used thus giving him an idea of where to locate the various rooms and also how to lay out their interiors. This matter has not been touched by this study, nor has the question of the influence of climate on building design. These are highly specialized matters which have been dealt with by the three regional centres that collected the data for this report. For further information on the work of these centres and a copy of their publication lists, write to:

Director, ARISBR, P.O. Box 1368, Colombo 7, Ceylon.

Director, REBIA, P.O. Box 1720, Khartoum, Sudan.

Director, CONESCAL, P.O. Box 41-518, Mexico 10, D.F.

APPENDIX I

TERMINOLOGY

This terminology refers exclusively to space, cost, economy factors and space utilization adopted for this study, taking into account the particular situation of the three regions involved.

1. General terminology

ADDITIONAL SPACE

Complementary areas or units not included within the educational, administrative, circulation or service space classifications, such as living accommodation, rooms for mechanical and electrical plant, bicycle sheds, bulk store rooms, warehouses, garages, etc.

ADDITIONAL WORK COSTS

The variable costs associated with buildings due to the vagaries of the site. These costs cannot be usefully ap- in unit cost planning of other buildings because of the large variation in shape, size and levels of the site and in access to utility services. It is for this reason that the *additional work costs* are kept separate from *the net building cost.* Additional work costs comprise the following :

a) drainage work beyond the manholes immediately adjacent to the school;
b) roads, paths and areas for informal games (other than games prescribed in the Building Regulations);
c) water, gas and electric mains (from meter point in building to connexion with the existing supply);
d) site layout and planting;
e) boundary walls and fencings;
f) playing-field preparation, including excavation;
g) staff house and dormitories (including drainage);
h) bicycle sheds, greenhouses, etc. (if physically detached from the main school building or buildings);
i) electricity substations, sewage disposal plants, etc.;
j) any contingency sum allocated to the above;
k) the proportion of preliminary costs and insurance allocated to the above;
l) fees in connexion with the above items.

ADMINISTRATIVE SPACE

Areas used by the administrative staff or faculty for administrative purposes. Included are : the office(s) for student societies and organizations, teachers' office and lounges, and storage related to administration.

BALANCE OF PAYMENTS

According to the definition of the International Monetary Fund, it is the systematic accounting of all economic transactions that have taken place during a certain period of time, between national and foreign economic subjects.

CIRCULATION AREAS

The areas for horizontal and vertical movement of the occupants of the school, within or adjacent to the building, including : corridors, lobbies, staircases, (covered or uncovered), lift shafts (elevators), verandas, balconies, covered ways linking buildings, etc.

CLASS

A group of pupils who are usually instructed together during a school period by one or several teachers.

CLASSROOMS

Spaces for lecture-type instruction.

COMMUNAL EDUCATIONAL SPACE

Common areas which are used at the same time by several classes (geography, history, audio-visual, language laboratory, music, etc.)

CONSUMPTION CAPACITY

The consumption capacity as estimated by establishing a relationship between price and income.

COVERED AREA

Area determined by the horizontal projection of the roofs.

DESIGN CAPACITY

The maximum number of students who could use the classroom as designed in adequate working conditions. For this purpose, in cases where data is not available, it is necessary to adopt standards or averages indicating the number of square metres per student for each type of educational room.

DESIGN COST

The total cost of professional fees charged for the elaboration of the design project and site supervision. The execution of the project includes the design of architectural, structural and general installations. When schools are designed by private architects, the cost estimation should be based on general fees. For departmental design, normal consultants' fees should be assumed.

DIRECT COST OR EXPENSES

The expenses or investment closely related with the production of the goods or commodity. Usually, they refer to the payment of labour, raw materials, equipment depreciation and energy used in the production process.

EDUCATIONAL SPACE FOR INDIVIDUAL CLASSES

Spaces used by a single class (classroom, laboratory, workshop)

EDUCATIONAL SPACE UTILIZATION

The ratio between the actual or predicted use of educational spaces and their possible or ideal use during the school week. The formula for calculating space utilization is shown elsewhere in this document.

ENROLMENT

The total number of students enrolled in the principal shift.

EQUIPMENT

Teaching aids such as furniture, machine, tools, etc., for worskshops and laboratories, audio-visual aids, library, book shelves, etc.

EXCAVATION AND FOUNDATIONS

Excavation and earthworks. Comprises all necessary earth and rock displacement for the laying of foundations, including set out and grading, excavations, fillings and disposal of surplus soil. It does not include clearing, grubbing and demolition of obstacles, temporary structures and utility buildings, or drainage tests.

Foundations. Includes soil compacting, slabs as a base for foundations, footings, concrete ground beams for levelling, damp-proofing and other parts which refer to the elements below the ground floor level. Materials and labour in respect of plumbing and sewerage and electrical installation below ground floor level are not included.

FINISHING MATERIALS

Includes finishes and decoration of walls, ceiling, floors and other surfaces, and built-in furniture, materials and labour. Plastering, painting, acoustic tiles; cement, ceramic and quarry floor tiles, etc., applied to vertical, horizontal or other elements of the building for the purpose of protection or decoration are included.

This element is subdivided into five sub-elements :

Walls
Ceiling
Floor
Other surfaces
Built-in furniture

FLOOR LEVELS

The floors are designated as follows :

Ground floor : That floor which is nearest to the ground level.
First floor : That floor which is next above the ground floor
Second floor : The floor immediately above the first floor, and so on.

FURNITURE (classroom)

All equipment not built-in, consisting of desks, chairs, benches, tables, cupboards, etc.

GRADE

An instruction step usually covered in the course of a school year.

GROSS AREA

The total constructed area of a school comprising educational, administrative, service, circulation, additional spaces, and wall section areas, as defined in other parts of this document.

GROSS COST

The sum of the net cost, design cost and additional works costs.

GROSS NATIONAL PRODUCT

The sum of the total value of goods and services produced within a certain period of time, usually one year, with the aid of labour, capital and national resources, once the previous expenses have been deducted.

GROSS NATIONAL PRODUCT PER CAPITA

The Gross National Product divided by the total population of the country at a certain date.

GROUP

See " Class ".

HORIZONTAL ELEMENTS AND VERTICAL CIRCULATION

Includes the following sub-elements :

Ground floor
The complete structure at this level, excluding floor finishes, filling and grading under floors. When the ground floor slab has been designed as a suspended slab, all beams including ground beams are included in this sub-element.

Intermediate floors
Floor slabs and supports between the ground floor and the roof, including beams required for supporting the floor, beams forming part of the frame, framework, material and labour. Floor finishes and ceiling are not included.

Vertical circulation
Vertical circulation comprises those elements connecting different floor levels.
a) Stairs (including landing, supporting structures, land places and railings.
b) Elevators (including shafts and motor rooms).

Roofs and roofing
Upper part of building which protects the inside against climatic factors. It includes roof decking and supports, material and installation, roofing and insulation, sky lighting if present, and the structure that transmits the loads which occur upon the upper part of the buildings to the columns of bearing walls. Roof timber, steel or concrete beams as decking support are included. Finishing or ceiling are not included.

INITIAL COST

Equivalent to net or gross cost, as the case may be.

LABORATORY

The classroom where practical work in biology, physics and chemistry takes place.

LABOUR PRODUCTIVITY

In the study, this concept refers to man-hour production.

LANGUAGE LABORATORY

Rooms with cubicles, earphones, and other audio-visual aids for learning a language.

LIVING ACCOMMODATIONS

Places where people live (student hostels or dormitories, academic and administrative staff housing, other staff housing for caretakers, guardians, etc.)

LOOSE FURNITURE

See furniture (classroom)

MAN HOURS

The work time, in hours, involved in the production of a commodity.

MECHANICAL INSTALLATION

Electrical installation
Complex of lines, conduit tubes and fixtures for the purpose of providing and distributing electrical energy to a building, furnishing and installation. Those appliances that use electrical energy are included, except electric motors for pumps and lighting rods. Excavating and back filling, conduits, conductors, fittings, bushings, boxes, panel boards, cabinets for panel boards, lighting fixtures and lamps, clocks and bells, public address system, etc., are included.

NET AND GROSS COST PER STUDENT ACCORDING TO DESIGN

These figures are obtained by dividing the net or gross cost of the school by the number of students according to the design capacity.

NET COST

The building cost excluding the cost of additional works, furniture and equipment.

NET UNIT AREA

Net Unit Area is measured between the walls, and includes annex areas such as closets, storage racks, etc. which form part of the unit.

NUMBER OF GRADUATE STUDENTS

Yearly total of students who have completed their studies in the different specialized fields of the institution.

NUMBER OF STOREYS

One storey buildings : those where all spaces are located on the ground floor.
Two storey buildings : those where ground and first floors are constructed.

OVERALL COST

The sum of gross cost, land, furniture and equipment costs.

OVERHEAD EXPENSES OR COSTS

The operation expenses of an enterprise. Includes administrative and office expenses, rent of the building and other items known as " general expenses ". For the purpose of the study, profits have been considered as indirect or overhead expenses. Includes taxes that can be identified, paid by contractor for the construction of a building.

PLUMBING AND SEWERAGE

Piping and equipment for the purpose of distributing water for consumption in the building and expelling sewage and vain water from the building, furnishing and installation. Water pump, excavating and back filling necessary, fixture, pipe cleanouts, etc., are included.

This element is subdivided into two sub-elements :

Plumbing and sewerage.

Special plumbing and sewerage for laboratories.

PURCHASING POWER

The existing relation between the nominal monetary unit and the amount of goods that can be purchased with it.

ROOM HEIGHT

Measured from finished floor level to soffit or ceiling.

SANITARY INSTALLATION

Provision of all sanitary fittings including : water, soil and waste pipes, underground drains and sewage disposal.

SCHOOL PLANT

Physical property belonging to the school, consisting of grounds, buildings and equipment.

SERVICE SPACE

Space which provides services to the whole school and which are found in nearly all schools (kitchen, dining, sanitary, student store, sick bay, etc.).

STOREY HEIGHT

Measured from finished floor level to next finished floor level.

STREAM

A division of children in one grade into two or more teaching groups.

STUDY CARRELS

Cubicles or space for individual study.

TEACHING SPACE

Rooms or areas set aside specifically for teaching. The assembly hall or auditorium is classed as a teaching space. Teaching space equals educational areas for individual classes plus communal spaces.

TOILET

Facilities including W.C. or its equivalent and lavatories, urinal, etc.

TOTAL COST

The sum of the initial cost and maintenance cost of the building or element during the lifetime of the building.

TOTAL ENROLMENT

Students attending all shifts.

TOTAL NET AREA

The sum of all net unit areas (comprising educational, administrative, service and circulation areas).

TOTAL NET PUPIL AREA

The total net area divided by the total number of students for which the school was designed.

UNIT

Spaces in a school grouped by function for convenience of measurements, e.g. classrooms, laboratories, circulation spaces, etc.

URINAL

Urine disposal facility usually provided in boys' toilets.

WATER CLOSET

Human waste disposal facility using water carriage system.

VERTICAL ELEMENTS

Load-bearing walls and columns.

Load-bearing walls and retaining walls above ground floor level, including stiffening, piers and columns to same, lintels, jambs, splays, etc.

Columns transmitting loads from beams and slabs to foundations. Columns supporting stairs are not included.

Non-load-bearing partition walls (infill panel walls, stiffening), light screens, lattices, etc.

Doors and windows or their equivalent, including frames, glazing and hardware.

Sun screens of all materials and types, both vertical and horizontal, and designed to protect doors, windows and the like, excluding venetian blinds.

WORKSHOP (General Secondary)

The school unit where practical activities take place, such as arts and crafts, home economics, elementary wood and metal working.

WORKSHOP (Technical)

The school unit where practical activities oriented toward vocational education take place, such as carpentry, technical drawing, welding, auto-mechanics, etc.

APPENDIX II

DATA COLLECTION FORMS

Note : The following forms were used for the collection of the data in this study and to process raw data into usuable figures on space utilization, proportions of the total building devoted to various uses, cost per m^2 and cost per pupil.

The key to the types of schools studied is as follows :

SG : Secondary General
TT : Secondary Teacher Training
ST : Secondary Technical
STA : Secondary Technical Agriculture
STI : Secondary Technical Industrial
STC : Secondary Technical Commercial
STV : Secondary Technical Vocational
STD : Secondary Technical Domestic Arts

SCA/1/1

SPACE AND COST ANALYSIS

GENERAL INFORMATION (1 of 2)

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

General data

SCHOOL

Name
Street
Town
District
Country
Phone
Principal

ARCHITECT

Public/private
Name
Address

CONTRACTOR

Name
Address

DATA COLLECTION

Data Source
Person
Investigator
Date

DATES

Date of design
Tendering date
Construction begun
Construction period
Opening date

Design capacity	Enrolment (Principal shift)	Number of shifts	Total enrolment

Type of school (code)

Type of instruction	SG		TT		ST	STA		STI		STC	STV	STD
Yéars required for entrance	I	II	III	IV		V	VI	VII	VIII		IX X	XI XII
Duration of Studies	1		2	3		4	5	6		7	8	9

Owner and location: Publicly owned / Privately owned / Urban / Sem-Urb. / Rural

Number and type of blocks

Block number	Description	No. of Storey	Included	Not included

Contract description

Type of contract	Contract sum Date / Number / Amount
	Total

SCA/1/2

COST AND SPACE ANALYSIS

GENERAL INFORMATION (2 of 2)

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

STANDARDS

NATIONAL OR LOCAL STANDARDS OR CRITERIA FOR COSTS AND SPACE

SITE

Site area (M^2) _____
Total area per pupil (M^2 _____
Play area per pupil (M^2) _____

BUILDINGS (net unit areas/pupil M^2)

Classrooms _____
Laboratories _____
Workshops _____
Others _____
Total: _____

COSTS

Cost per pupil place _____
Cost per M^2 of building _____

Capital Gross
Net
Total Net
Unit Area

EDUCATIONAL

General (classrooms) _____
Science (laboratories) _____
Practical (workshops) _____
Physical Education _____
Student/Teacher ratio _____

COSTS

EXCHANGE — Local currency – US $1.00

Unit	Sub-Items	Total Items
Land		
Land development (preliminaries)		
Additional works		
Special foundations		
Fees:		
Architect		
Consultants		
Contractor		
Administration		
Loose furniture		
Equipment		
Net Building Cost		
Mechanical Installation		
Plumbing and Sanitation		
CAPITAL COST:		

SCA/1/3

COST AND SPACE ANALYSIS

SPECIFICATIONS (1 of 1)

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

Site characteristics							Bearing cap.
Foundations	Con-tinuous footing	Independ. footing	Slab foundation	Shell found.	Piling found.		
Structural Frame	Concrete	Steel	Wood				Des. load
Roof Structure							Des. load
Walls							Load bearing
Partitions							
Roof covering							
Doors	External						
	Internal						
Windows							
Finishes	Walls						
	Ceilings						
	Floors						
	Other surfaces						
	Built in furniture						
Mechanical Installation or Service	Electrical installation						
	Air conditioned, heating and ventilation system						
Sanitary Services							
Furniture (classroom)							

SPACE ANALYSIS

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

SCHEDULE OF ACCOMMODATIONS AND AREA ANALYSIS (1 of 2)

Key	Type of room/space	No. of rooms	Net unit area: Area	Net unit area: %	Net area/sector: Area (m^2)	Net area/sector: %	M^2 per pupil: Desig.	M^2 per pupil: Enrol.	Remarks
	General classroom								
	Special classroom								
	Laboratories								
	Workshops								
	Educational space for ind. classes			100%					
	Communal educational space			100%					
	Administration space			100%					
	Service space			100%					
	Circulation area			100%					
	TOTAL NET AREA			100%					
	Living accommodation								
	Additional space			100%					
	TOTAL NET AREA, PLUS ADDITIONAL NET AREAS								

SCA/1/5

SPACE ANALYSIS

SCHEDULE OF ACCOMMODATION AND AREA ANALYSIS (2 of 2)

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

	Area	%	M^2 per pupil	
			designed	actual
Land				
Covered area				

Total net area	
Additional space	
Wall section area (net areas)	
Wall section area (additional spaces)	
GROSS AREA	

$$\frac{\text{Walls section area}}{\text{Gross area}} = \_\_\_\_$$

No. of storeys _____ | Storey height _____ | Room height _____

$$\frac{\text{Window and door area}}{\text{Wall area}} \quad \text{Ratio} = \_\_\_\_$$

Observations:

$$\frac{\text{External wall area}}{\text{Floor area}} \quad \text{Ratio} = \_\_\_\_$$

Observations:

Toilet fittings	Data	W.C.	Urinals	Showers	Sinks	Others
Male	Units					
	Enrolment					
	Ratio					
Female	Units					
	Enrolment					
	Ratio					

SCA/1/6

SPACE ANALYSIS

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

NUMBER OF ROOMS REQUIRED (1 of 2)

No. of classes, groups and number of periods taught in each grade and space unit

No. of possible periods per week: P_o =

Grade	Enrolments	SPACE															
		Classrooms General (1)			Classrooms Special (2)			Laboratories (3)			Workshops (4)			(5)		
		Number of classes or groups a	Periods per class b	Tot. class periods per grade (a×b) c	a	b	c	a	b	c	a	b	c	a	b	c
Total																	

Total No. of classes (groups) = Sum of column a.

Total class (group) periods per space = Sum of column c. (Σ c)

Actual No. of spaces available and minimum No. of spaces required

Needed No. of space (s) in each space unit:

$$s = \frac{\text{Sum of c}}{i \cdot P_o}$$

i = assumed factor of space utilization

$$i = 100\% \quad s = \frac{\Sigma \ c}{P_o}$$

$$i = 80\% \quad s = \frac{\Sigma \ c}{P_o}$$

SCA/1/7

SPACE ANALYSIS

NUMBER OF ROOMS (2 of 2)

Ref. No. _____
Card No. _____
Carded by: _____
Checked by: _____

S P A C E	Rooms required					Existing rooms
	Σ c	i = 100%		i = 80%		
		P_o	$\frac{\Sigma c}{P_o}$	$0.8 P_o$	$\frac{\Sigma c}{0.8 P_o}$	
(1) Classroom, general						
(2) Classroom, special						
(3) Laboratories						
(4) Workshops						
(5)						

P E R S O N N E L (Principal Shift)	Number of Personnel
Teachers	
Administrative	
Service	

SCA/1/8

COST ANALYSIS SHEET

COST ANALYSIS (1 of 1)

Ref. No. _____
Card No. _____
Carded by _____
Checked by _____

Breakdown of Capital Costs National Currency			
UNIT	COST	% COST per pupil-design capacity	COST per M^2
Capital Cost		100	**
Land			
Land development cost and prelimin.			
Additional cost			
Design cost			
Loose furniture			
Equipment			
Net building cost (Nat. Cy)			**
Net building cost (U.S. dollars)			**
Net building cost		100	
General classrooms			*
Special classrooms			*
Laboratories			*
Workshop			*
Common rooms			*
Assembly hall			*
Gymnasium			*
Circulation Space			*
Administrative Space			*
Toilets			*
Additional works cost			*
Design costs			
** Total Net Area * Net Unit Area			

APPENDIX III

DATA TOPICS INCLUDED IN THE STUDY

Topic group	Topic number	Topic
Type of school	1	School reference number
	2	Date built
	3	General secondary school Technical secondary school Teacher-training school
	4	Boys' school Girls' school Co-educational school
	5	Boarding school Day school Boarding and day school
	6	Urban location Suburban location Rural location
	7	Number of shifts worked
Size of school	8	Design capacity
	9	Number of enrolled pupils
	10	Number of enrolled pupils compared to design capacity
	11	Number of teachers
	12	Pupils per teacher
	13	Number of administrative staff
	14	Number of service staff
Area per pupil m^2	15	Total day area
day area excludes living accommodation	16	Area per enrolled pupil
	17	Number of separate buildings
	18	Number of storeys
	19	Area per pupil in general classrooms
	20	Area per pupil in special classrooms
	21	Area per pupil in laboratories
	22	Area per pupil in workshops
	23	Area per pupil in education space
	24	Area per pupil in communal space
	25	Area per pupil in administrative space
	26	Area per pupil in service space
	27	Area per pupil in circulation space
Division of area	28	Educational space as percentage of total day area
	29	Communal space as percentage of total day area
	30	Administrative space as percentage of total day area
	31	Service space as percentage of total day area
Division of area	32	Circulation space as percentage of total
Area per station m^2	33	Area per station (general classrooms)
	34	Area per station (special classrooms)
	35	Area per station (laboratories)
	36	Area per station (workshops)
	37	Site area per pupil
	38	Play area per pupil
Sanitary provision	39	Pupils per WC
	40	Pupils per urinal
	41	Pupils per shower
	42	Pupils per sink
Living area	43	Living area per pupil, boarding schools
Teaching group size	44	Number of teaching groups
	45	Pupils per teaching group
	46	Percentage enrolment age 12
	47	Percentage enrolment age 13
	48	Percentage enrolment age 14
	49	Percentage enrolment age 15
	50	Percentage enrolment age 16
	51	Percentage enrolment age 17
	52	Percentage enrolment age 18
	53	Minimum age group as percentage maximum
	54	Age 12 group size
	55	Age 13 group size
	56	Age 14 group size
	57	Age 15 group size
	58	Age 16 group size
	59	Age 17 group size
	60	Age 18 group size
	61	Maximum group size
	62	Minimum group size
Timetable analysis and room use	63	Total group periods
	64	Period length in minutes
	65	Hours per group per week
	66	Hours per teacher per week
	67	Hours per group (general classrooms)
	68	Hours per group (special classrooms)
	69	Hours per group (laboratories)
	70	Hours per group (workshops)
	71	Hours per room (general classrooms)
	72	Hours per room (special classrooms)
	73	Hours per room (laboratories)

Topic group	*Topic number*	*Topic*
Timetable analysis and room use	74	Hours per room (workshops)
	75	Hours per station (general classrooms)
	76	Hours per station (special classrooms)
	77	Hours per station (laboratories)
	78	Hours per station (workshops)
Cost per pupil $	79	Cost per pupil net (buildings only)
	80	Cost per pupil for additional works
	81	Cost per pupil for land
	82	Cost per pupil for design
	83	Cost per pupil for furniture
	84	Cost per pupil for equipment and furniture
Cost analysis by type of space $: m^2	85	Cost per m^2 net
	86	Cost per m^2 for additional works
	87	Cost per m^2 for land
	88	Cost per m^2 for design
	89	Cost per m^2 for furniture
	90	Cost per m^2 for equipment and furniture
	91	Cost per m^2 for general classrooms
	92	Cost per m^2 for special classrooms
	93	Cost per m^2 for laboratories
	94	Cost per m^2 for workshops
Cost analysis by type of space $: m^2	95	Cost per m^2 for administrative space
	96	Cost per m^2 for service space
	97	Cost per m^2 for toilet space
	98	Cost per m^2 for circulation space
	99	Cost per m^2 for communal space
Cost analysis by building elements $: m^2	100	Cost per m^2 for foundations
	101	Cost per m^2 for vertical elements
	102	Cost per m^2 for horizontal elements
	103	Cost per m^2 for finishes
	104	Cost per m^2 for sanitary elements
	105	Cost per m^2 for electricity service
	106	Cost per m^2 for structure
Building specification	107	Type of site
	108	Type of foundations
	109	Type of structure
	110	Type of walls
	111	Type of upper floors
	112	Type of roof structure
	113	Type of roof covering
	114	Type of partitions
	115	Type of windows
	116	Type of finishes
	117	Electricity service
	118	Heating and ventilation service
	119	Sanitary service

APPENDIX IV

COUNTRIES INCLUDED IN THE STUDY

Fourteen countries representing a cross-section of the Third World participated in this study. A variety of climates, economic levels and cultures are represented. Since the data was provided by the Member States in confidence, the names of the participating countries have not been included in this report. However, the chart below will help to give the reader an idea of the variety of countries treated in this report.

Country Symbol	*Location*	*GNP per capita*
W. Af	West Africa	$200 +
S.E. Af	South East Africa	50 +
N.W. Af	North West Africa	150 +
N.E. Af	North East Africa	50 +
E. Af	East Africa	50 +
W. As	West Asia	50 +
C. As 1	Central Asia	150 +
C. As 2	Central Asia	50 +
W. As	West Asia	250 +
E. As	East Asia	550 +
C. Am 1	Central America	450 +
C. Am 2	Central America	500 +
W. SA 1	West South America	500 +
W. SA 2	West South America	300 +

APPENDIX V

ANALYSIS OF DATA

The data collected in Appendix III under 119 topic headings was analysed under four group headings :

type of school
space
utilization
cost and specification

Some additional data on national economic, geographic and climatic conditions were examined.

Where possible, graphs are used to illustrate findings, and matrices to show how various sub-divisions into school type, location or form have a bearing on any conclusions which may be drawn. The small sample of 100 schools and the lack of information under many topic headings does not allow a precise analysis but many of the broad conclusions provide a basis for planning school programmes and individual buildings, as well as providing a measure for comparison of data gathered in other countries.

The data given in Appendix III is held on a magnetic tape file and graphs have been drawn using a digital plotter output from a computer. Matrices have been constructed using a co-ordinate index card system. Sixty-nine different graphs or matrices were generated by these means but only nineteen of the most illuminating analyses have been included here for reasons of space.

In arriving at average values for particular topics, the median value of a series has been employed in order to minimize the effect of the great variations found in the data. Median values are indicated, where appropriate, on the matrices.

Matrices are constructed by grouping values with increments picked to suit the range and arrangement of recorded values. Where these groups of values are discrete, they are marked with a + or – sign after the column heading, i.e. 200 – means from the previous lower value up to 200; 200 + means from 200 up to the next value. Where the groups are cumulative, the sign is in front of the column heading i.e. – 200 means all values below 200; + 200 means all values above 200.

It should be noted that apart from living area (topic 43), the term area means day-school area; that hours, not teaching periods, are used to measure time and that all costs are in US dollars derived from national currency using exchange rates.

TYPES OF SCHOOLS IN INDIVIDUAL COUNTRIES

Matrix 1 shows the number of general secondary, technical secondary and teacher-training schools studied; whether the schools are boarding or day schools, or both; their location; whether one or two shifts are worked and finally the number of schools with different storey heights. Study of the data shows the contrast between co-educational urban day schools, three or four storeys high, and boys' rural boarding schools in single-storey buildings, (E As and E Af); between these extremes are co-education rural schools in single-storey buildings (C As 1) and many other combinations.

MATRIX 1

TOPIC 1

	COUNTRY														
Topic	Totals	W Af	S.E. Af	N. Af	NE Af	W Af	W As	C As 1	C As 2	W As	E As	C Am 1	C Am 2	W SA 1	W SA 2
General secondary	83	5	6	9	9	9	5	7	7	5	3	3	8	4	3
Technical secondary	13	2									2	7		2	
Teacher training	4		3									1			
Boys	24	2	7	3	3	5	1		3						
Girls	14	1	1	1	6	4			1						
Co-ed	17	4		4				2	3		4				
Boarding	30	7	8	1	5	8								1	
Day	67			7	3	1	5	7	7	5		11	8	5	3
Day + boarding	3		1	1	1										
Urban	32		1	9	6	2	4	1	4	1	4				
Suburban	16	5	4		2	1		2	2						
Rural	18	2	4		1	6		4			1				
One-shift	89	7	9	9	9	9	2	7	4	5		11	8	6	3
Two-shift	11						3		3		5				
One storey	31	3	2		⑦	4	1	⑥	1		1	3	2	1	
Two-storey	37	④	⑦	2	2	④	②	1	③	④		1	④		③
Three-storey	18			⑥		1			1	1	1	③		3	
Four-storey	11			1			2		1		③	4			

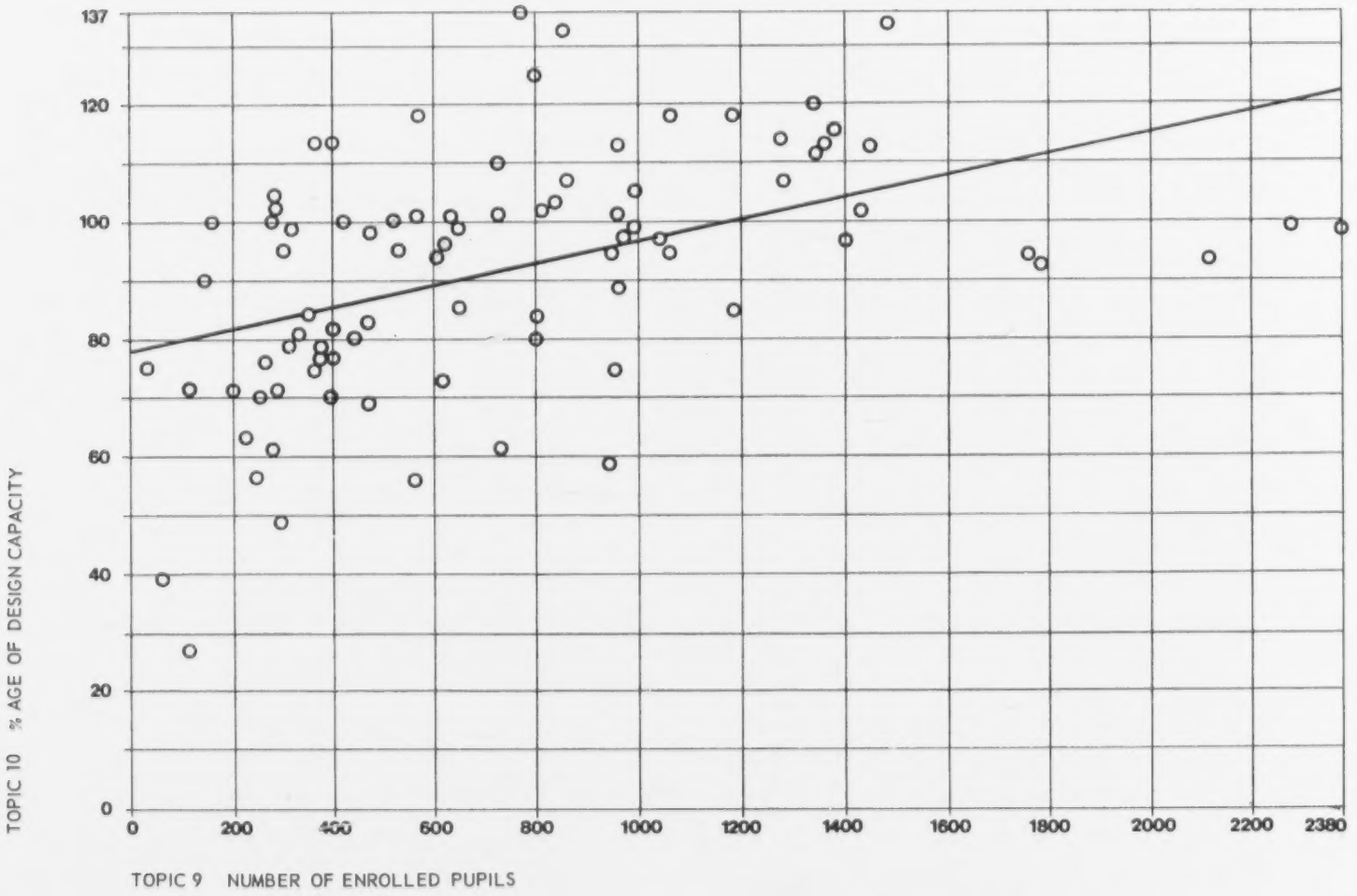
Key to symbols used to indicate median values on matrices

- □ indicates the median value for a horizontal row of values
- ○ indicates the median value for a vertical column of values

DESIGN CAPACITY AND NUMBER OF ENROLLED PUPILS

Graph 2 which compares actual enrolments with the design capacity of the schools, indicates that smaller schools, particularly those with less than 600 pupils, tend to operate at less than their design capacity.

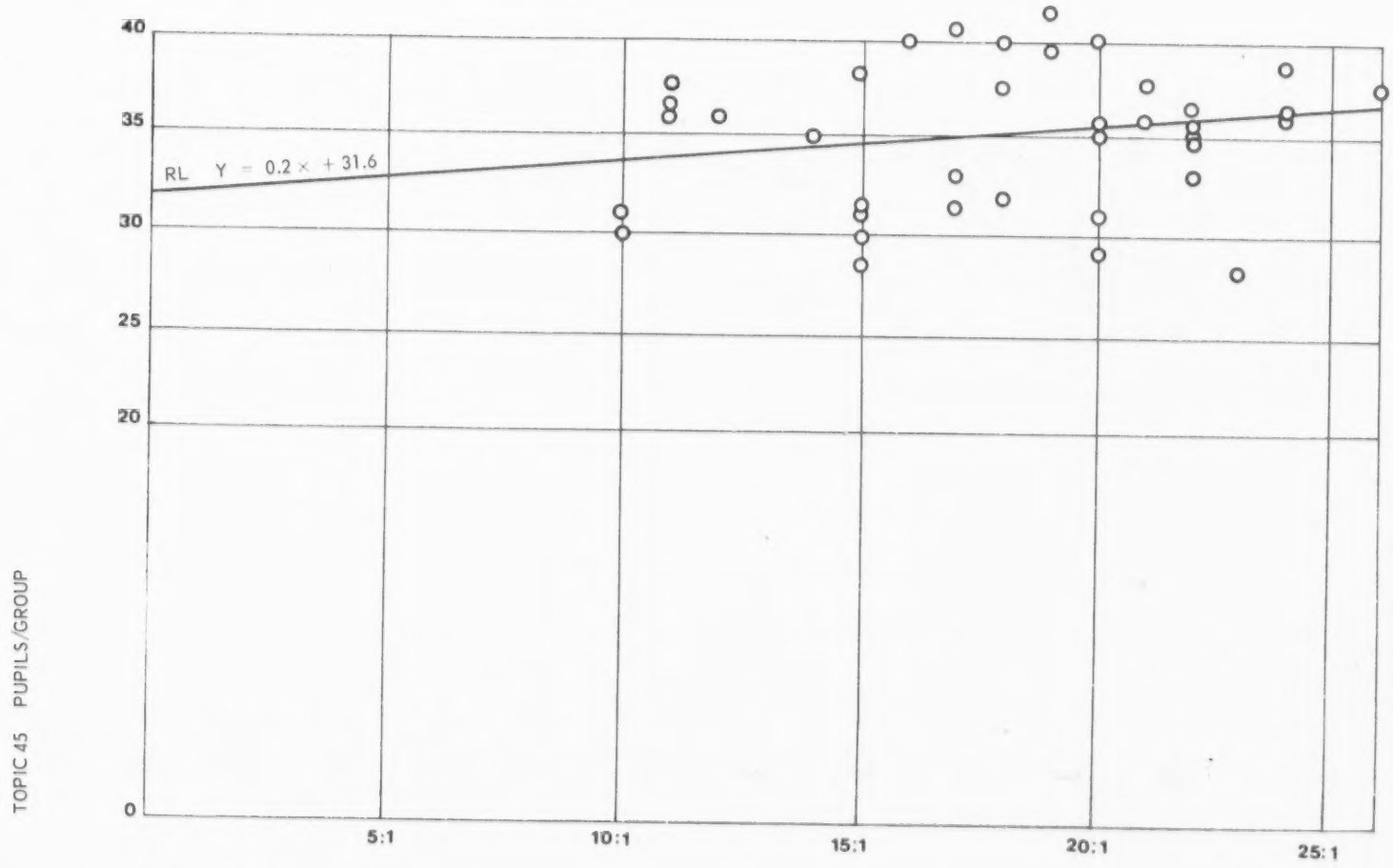
GRAPH 2



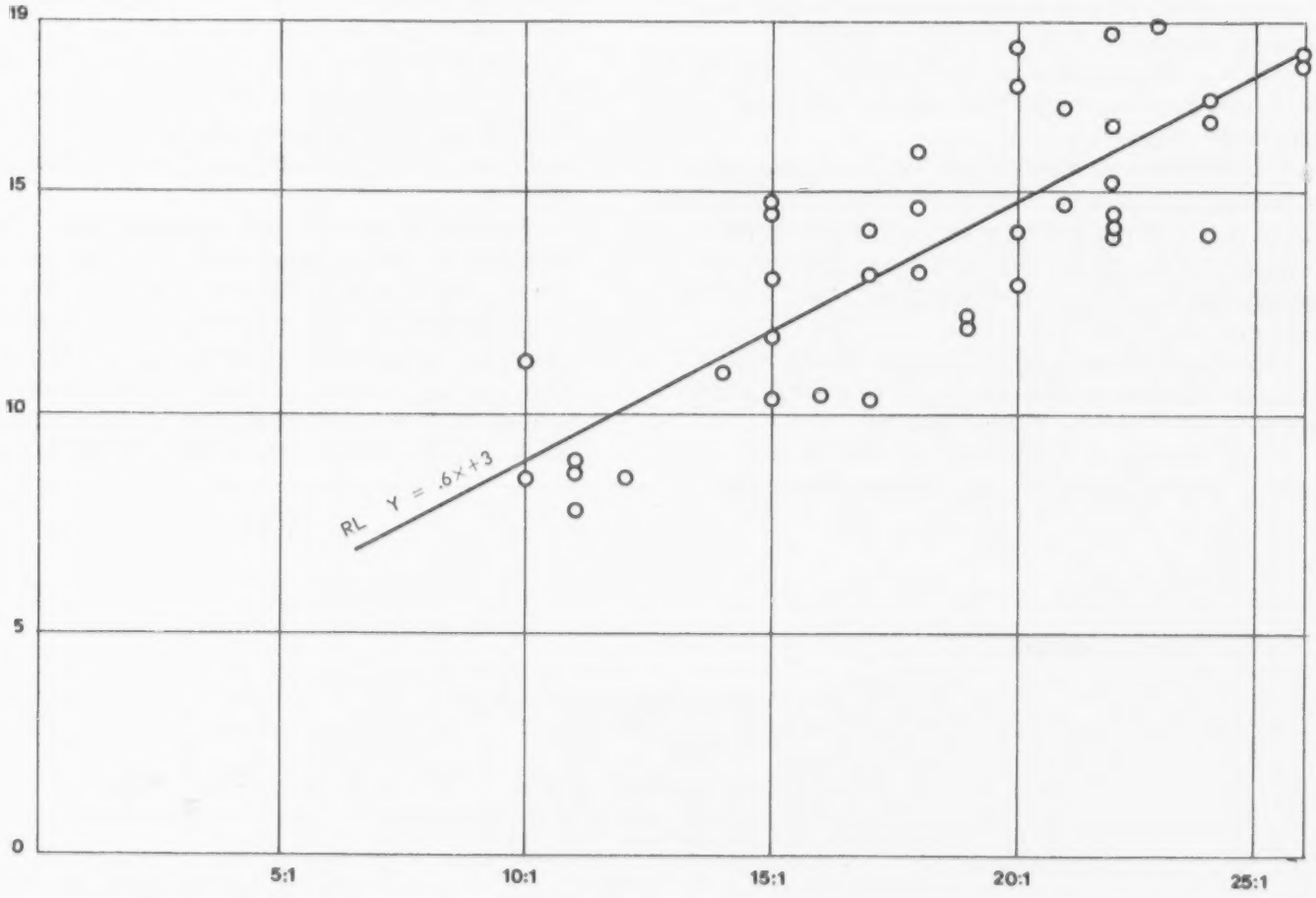
PUPILS/GROUP AND HOURS/TEACHER

Graph 3 shows that schools with low pupil teacher ratios also tend to have smaller classes. Graph 4 shows that in schools with low pupil teacher ratios, teachers teach relatively few hours per week. In other words, in schools with a low pupil teacher ratio, teachers work less, pupils work less and the groups or classes are smaller. Pupil contact hours may well be a measure of the strain on an individual teacher and range from about 220 (8 hours x 28 group) to 760 (19 hours x 40 group).

GRAPH 3



GRAPH 4


19
15
10
5
0
RL Y = .6X+3
5:1
10:1
15:1
20:1
25:1
TOPIC 66 HOURS/TEACHER/WEEK
TOPIC 12 PUPIL/TEACHER RATIO

AREA/PUPIL NET

The most direct way of analysing space provided in a school is per capita, either of pupils or teachers.

Matrix 5 relates area/pupil to the size of a school and shows that smaller schools have a greater area/pupil ratio than larger schools.

A comparison of area/pupil is mainly of value when examining schools with similar educational and geographical factors. The day school areas of the schools were analysed and compared. Matrix 6 shows that African schools have a median area of 6 to 8 m^2, Asian 3 to 4 m^2 and Latin America 4 to 5 m^2.

Technical secondary schools have a median area of 6 to 8 m^2 compared with 4 to 5 m^2 for general secondary and over 8 m^2 for teacher training.

There is no significant difference between boys' schools, girls' schools or co-educational schools but boarding schools with 6 to 8 m^2 per pupil have twice the median area per pupil of day schools. Median values for different types of schools are : urban schools, 4 to 5 m^2 per pupil; suburban about 6 m^2; and rural, 6 to 8 m^2. Values indicate how pressure on accommodation and land in urban areas influences the amount of space allotted.

The greater area per pupil in single-storey schools is probably due to the large number of rural and/or boarding schools. Simplicity of construction and the possibility of cheaper cost per m^2 may allow more freedom in planning and give less reason for economizing on space than in designs of two or more storeys. Two-storey schools have the smallest median area per pupil and three-and four-storey schools only slightly more.

MATRIX 5

TOPIC 9 ENROLLED PUPILS

		Totals	200 –	400 –	700 –	1000 –	1500 –	2400 –
16 Area/pupil M^2	2 –	5		1		2	1	1
	3 –	9		2	1		3	(2)
	4 –	20		2		5	(10)	1
	5 –	12		1	5	(4)	2	
	6 –	10		4	2			
	8 –	16	2	(7)	(2)	4	1	
	12 –	15	1	8	4	2		
	12 +	6	(4)		2			

◯ Designates average in vertical column

MATRIX 6

TOPIC 16 AREA/PUPIL M^2

	Totals	1+	2+	3+	4+	5+	6+	8+	12+
Topic	100	6	14	21	[12]	10	16	15	6
1 Africa	43	3	3	3	1	7	[10]	11	5
Asia	28	2	10	[7]	3	1	4	1	
Latin America	29	1	1	11	[8]	2	2	3	1
3 General secondary	83	6	14	19	[11]	7	13	11	2
Technical secondary	13			2	1	2	[2]	4	2
Teacher	4					2	1		2
4 Boys	24		3	3	2	4	[4]	3	5
Girls	16				2	5	[4]	5	
Co-ed	17	1	2	4			[6]	4	
5 Boarding	29			3		4	8	10	4
Day	66	5	14	[18]	12	5	7	5	1
Day + boarding	3	1				[1]	1		
6 Urban	32	3	6	6	[2]	6	5	4	
Suburban	16	1	1	2	2	2	[2]	4	2
Rural	18		2	2			[6]	5	3
7 One - shift	89	6	13	19	[10]	9	13	13	6
Two - shift	11		1	2	2	[1]	3	2	
18 One - storey	31	2	2	4	3	2	[9]	7	2
Two - storey	39	2	9	[11]	2	4	2	6	3
Three - storey	18	2	2	3	[5]	3	2		1
Four - storey	11		1	3	1	[1]	3	2	

[ ] Designates average in horizontal line

AREA PER PUPIL IN EDUCATIONAL, COMMUNAL, ADMINISTRATIVE AND SERVICE SPACE

Educational area comprises four categories, general classrooms, special classrooms (for arts and crafts, geography), laboratories and workshops.

The education space is the primary functional area of a school and all other space for administrative, communal, service and circulation needs can be compared with area/pupil for educational purposes. Matrix 7 shows how educational space per pupil (as well as administrative space, communal space and service space) tends to be less in larger schools.

Communal space includes assembly halls, dining-rooms, and libraries; administrative space includes staff rooms and offices; and service space, all lavatories, cloakrooms, kitchens, and stores. Matrix 7 shows how smaller schools have a far greater area per pupil for these functions.

MATRIX 7 TOPIC 9 ENROLLED PUPILS

Topic		Totals	200 –	400 –	700 –	1000 –	1500 –	2400 –
23 Area/pupil educational M^2	1 –	1		1				
	1 +	11				3	4	(4)
	1.5 +	19	1	2	4	4	(7)	1
	2 +	(32)	1	(10)	(6)	(9)	5	1
	3 +	14	1	6	4	2	1	
	4 +	16	(4)	6	4	2		
24 Area/pupil communal M^2	0.5 –	28		6	6	5	7	(4)
	1 –	(13)		(6)	(1)	(4)	1	1
	2 –	12	2	4	3	3		
	3 –	6	1	3	2			
	3 +	6	(4)	1	1			
25 Area/pupil admin. M^2	0.25 –	(52)	2	8	(9)	(16)	(13)	(4)
	0.5 –	18		(6)	4	2	4	2
	0.75 –	11		6	3	2		
	1.0 –	5	1	4				
	1.25 –	4	(2)		2			
	1.25 +	3	2	1				
26 Area/pupil service M^2	0.5 –	(58)		11	(10)	(15)	(18)	(4)
	1.0 –	16		(8)	4	3		1
	1.5 –	10	1	4	3	2		
	2 –	4	(3)	1				
	2 +	4	3		1			
27 Area/pupil circulation	0.5 –	13	1	5	2	1	2	2
	1.0 –	10		1		5	3	1
	1.5 –	(30)		5	(8)	(7)	(9)	(1)
	2 –	24	(3)	(9)	4	6	1	1
	2.5 –	12	2	6	1	2	1	
	2.5 +	4	1		2			1

AREA/PUPIL : CIRCULATION SPACE

Unlike all other space in a building, circulation area is only necessary to link the parts and should be kept to a minimum. It is however, the least controlled space.

The study found a range of 0 to over 2 m^2 per pupil with smaller schools generally having the larger areas. Matrix 7 (topics 9 and 27) shows the pattern. The analysis of circulation space under different school types is given by matrix 8. The regions show contrasts, Africa with a high median of 1.5 to 2 m^2 per pupil, and, except for some difference between boarding, day, urban and rural schools, all median values between 1 and 1.5 m^2.

MATRIX 8

TOPIC 27 AREA/PUPIL CIRCULATION M^2

	Totals	0.5 –	0.5 +	1 +	1.5 +	2 +	2.5 +
Topic	100	13	17	[30]	24	12	4
1 Africa	43	6	3	9	[15]	8	2
Asia	29	6	[9]	9	4		1
Latin America	28	1	5	[12]	5	4	1
3 General secondary	83	12	15	[27]	18	9	2
Technical secondary	13		2	3	[5]	2	1
Teacher training	4	1			1	[1]	1
4 Boys	24	3	3	[7]	4	5	2
Girls	14			6	[7]	1	
Co-ed	17	4	1	3	[7]	2	
5 Boarding	30	2	1	6	[12]	7	2
Day	67	11	15	[23]	12	4	2
Day + barding	3		1	[1]		1	
6 Urban	32	4	6	[11]	9	1	1
Suburban	16	2	1	5	[4]	3	1
Rural	18	6		1	[6]	4	1
7 One - shift	89	13	17	[24]	20	12	3
Two - shift	11			[6]	4		1
18 One - storey	31	8	1	[8]	8	5	1
Two - storey	39	2	10	[11]	8	7	1
Three - storey	18	3	4	[5]	5		1
Four - storey	11		2	[5]	3		1

AREA/PUPIL GENERAL CLASSROOMS

General classroom space is the generator of all other space in a school. As far as can be ascertained from the survey information, the curriculum followed in all schools demands that pupils be taught in general classrooms for most of the time.

Nearly all schools have between 1 and 2 m^2 per pupil enrolled with a tendency for smaller schools to have the larger amounts. This 1:2 m^2 range contrasts noticeably with the range of 1:12 m^2 per pupil for total area shown in matrix 9. The median of 1.4 to 1.7 m^2 is consistent over the middle range.

MATRIX 9

TOPIC 16 AREA/PUPIL M^2

Topic		Totals	2–	3–	4–	5–	6–	8–	12–	12+
19 Area/pupil general class M^2	1–	9	⑧	1						
	1.4–	21	4	⑤	4	2	3	2	1	
	1.7–	21		1	④	①	③	⑥	⑥	1
	2–	14			1	1	1	4	5	②
	2.5–	5					1	3	1	
	2.5+	2								2
20 Area/pupil special class M^2	.4–	18		③	④	③	④	2		2
	.7–	12			1	1	2	④	4	
	1.0–	6						3	③	
	1.5–	6						2	4	
	1.5+	3							2	1
21 Area/pupil labs M^2	.25–	24	④	⑧	⑥		3	1		2
	.75–	27	1	5	4	④	⑤	⑧		
	.75+	21						5	⑬	③
22 Area/pupil workshops M^2	0	56	④	⑩	⑧	③	⑦	⑬	⑨	2
	0.5–	7	1	2	1	1			2	
	1–	4		1	1		1		1	
	1+	5						1	1	3

Note: Latin American schools not included.

AREA/STATION : GENERAL CLASSROOMS

Area/station in general classrooms is an important generator of area per pupil, since most seats are occupied most of the teaching week. Matrix 10 shows that seat space varies from less than 1.5 to over 2 m^2 and that 47 per cent of schools have less than 1.5 m^2 and 75 per cent less than 1.75 m^2.

Latin American, general secondary, urban, day and two- three- or four-storey schools have less than 1.5 m^2.

Asian schools, for which precise data were not available, probably have significantly less than 1.5 m^2 per station.

MATRIX 10

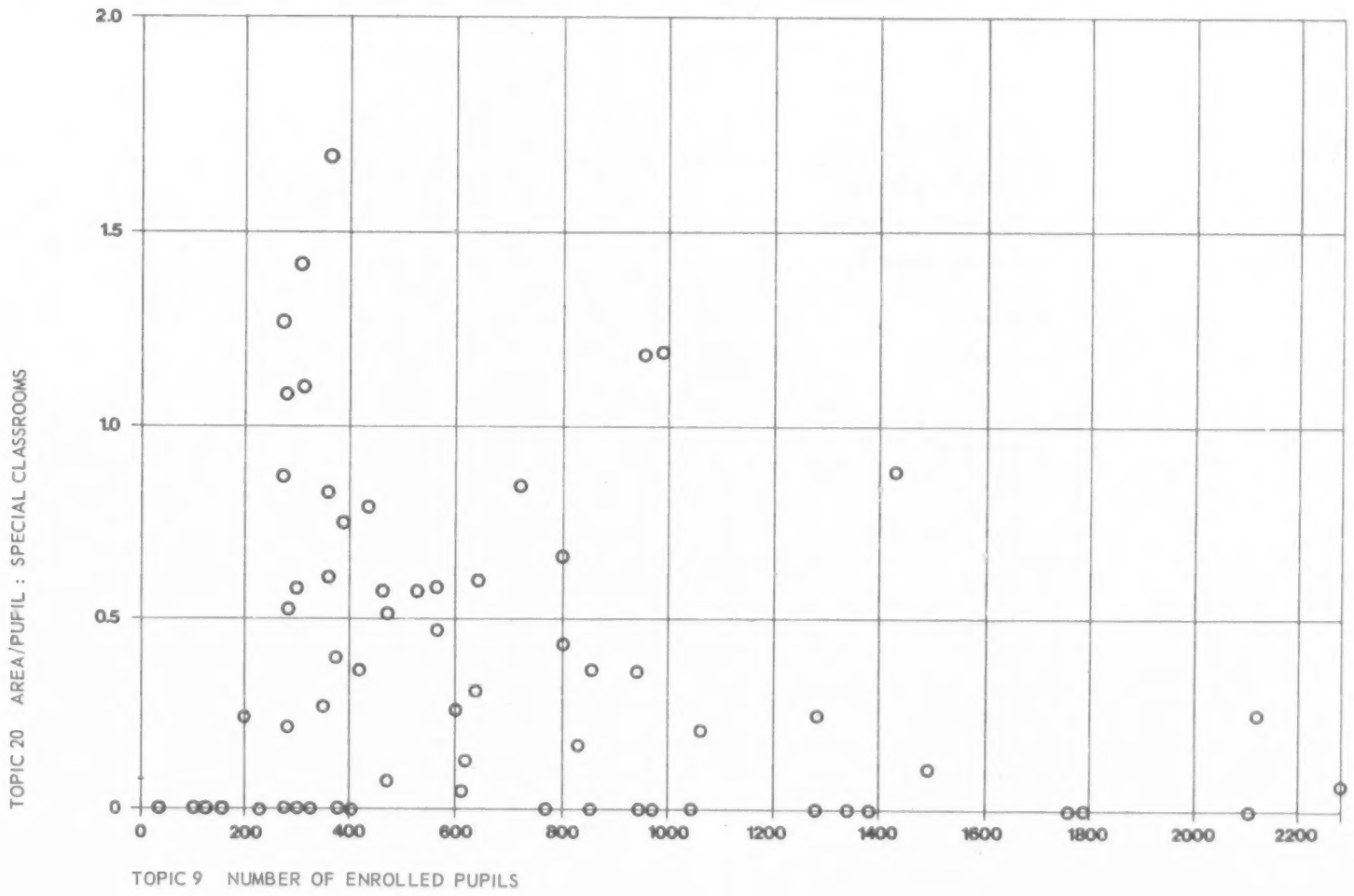
TOPIC 33 AREA/STATION: GENERAL CLASSROOMS

	Totals	1.5–	1.75–	2.0–	2.04–
Topics	71	33	[20]	12	6
1 Africa	43	16	[16]	10	1
Latin America	28	[17]	4	2	5
3 General secondary	56	[29]	15	10	2
Technical secondary	11	4	[2]	1	4
Teacher training	4		[3]	1	
4 Boys	20	7	[8]	5	
Girls	13	4	[5]	4	
Co-ed	8	[4]	[2]	1	1
5 Boarding	30	6	[13]	10	1
Day	38	[26]	5	2	5
Day + boarding	3	1	[2]		
6 Urban	18	[14]	4		
Suburban	12		[7]	5	
Rural	13	2	[5]	5	1
7 One-shift	71	33	[20]	12	6
18 One-storey	21	4	[10]	5	2
Two-storey	28	[15]	7	6	
Three-storey	15	[11]	2	1	1
Four-storey	5	[3]	1		1

AREA/PUPIL : SPECIAL CLASSROOMS

Special classrooms are rooms usually devoted to teaching geography, arts and crafts, or technical subjects not requiring laboratory or workshop facilities. The survey information indicates that they do not differ greatly from general classrooms in physical requirements. Special storage or display needs or the presence of a teacher for the particular subject may be reasons for their existence. The distribution and number of special classrooms is varied, as shown in graph 11. The rooms are considerably underutilized in many schools. The graph shows that schools in the 200 to 400 enrolment range have an area per pupil in special classrooms of up to 1.5 m^2 but that larger schools tend to have between 0.25 and 0.5 m^2 per pupil, if any such rooms are provided. 37 per cent of schools have no special classrooms. Matrix 9 gives details.

GRAPH 11

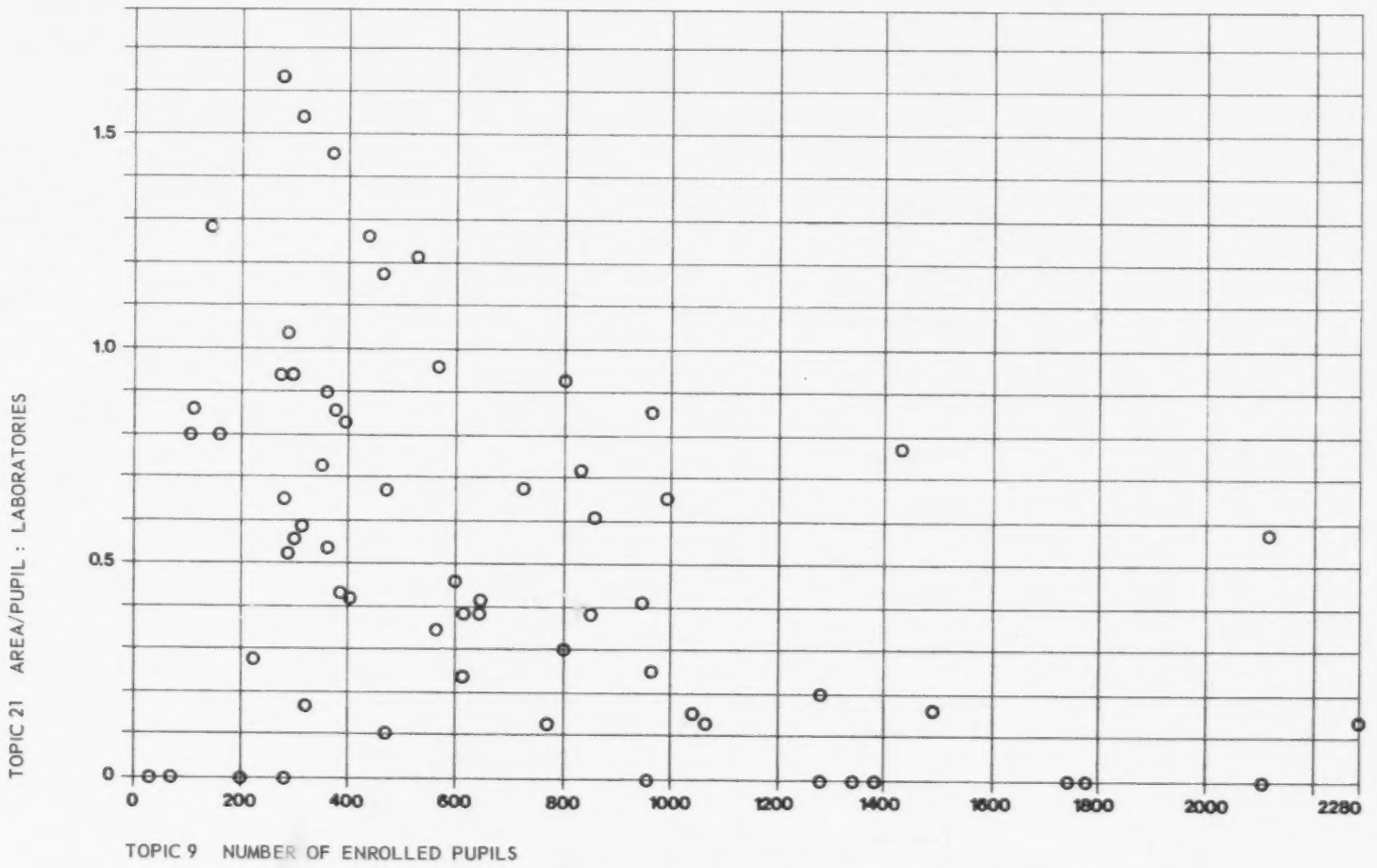


AREA/PUPIL : LABORATORIES

Laboratories may be for general science or for a single science subject. Area differences between different subjects have not been analysed. Graph 12 shows the range of area per pupil recorded, from less than 0.2 to over 1.5 m^2. The occurrence of larger areas in schools with smaller enrolment is fairly marked.

Matrix 13 analyses the effect of different types of school. Rural schools and boarding schools have a median value of over 0.75 m^2 per pupil as compared to a general median of about 0.5 m^2. Seventeen per cent of the schools have no laboratories, notably among those with enrolments of over 1200 pupils. Schools with under 600 pupils generally have considerably more special classrooms and laboratories than those with over 1200 pupils.

GRAPH 12



MATRIX 13

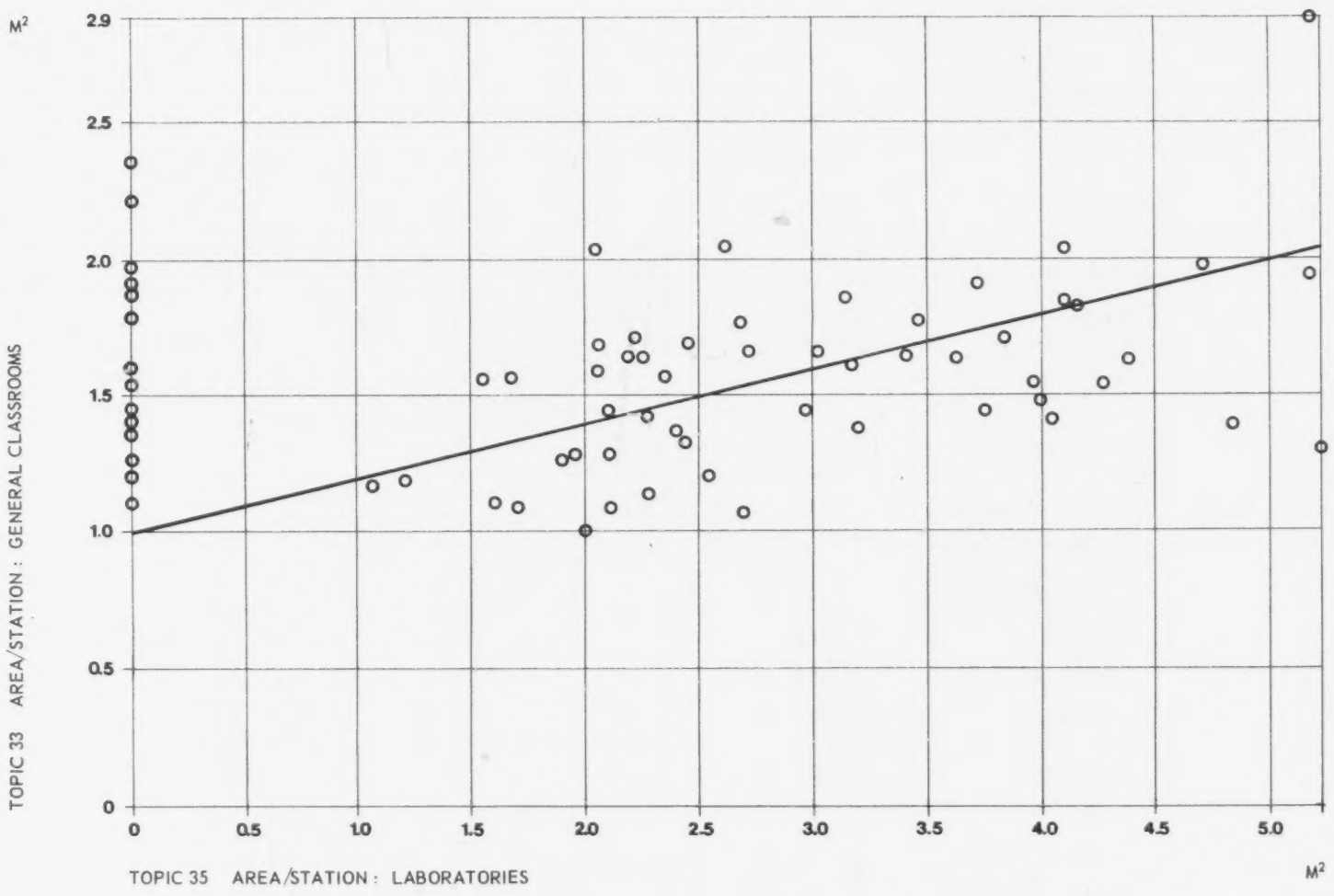
TOPIC 21 AREA/PUPIL : LABORATORIES

	Totals	0.25 –	0.75 –	0.75 +
Topics	72	24 33%	[27] 38%	21 29%
1 Africa	43	14 33%	[11] 26%	18 41%
Asia	29	10 35%	[16] 55%	3 10%
3 General secondary	65	21 32%	[27] 42%	17 26%
Technical secondary	4			[4] 100%
Teacher training	3	[3] 100%		
4 Boys	24	9 38%	[7] 29%	8 33%
Girls	14	1 7%	[7] 50%	6 43%
Co-ed	17	5 29%	[6] 35%	6 35%
5 Boarding	29	8 28%	5 17%	[16] 55%
Day	40	15 38%	[21] 52%	4 10%
Day + boarding	3	1 33%	[1] 33%	1 33%
6 Urban	32	11 34%	[16] 50%	5 16%
Suburban	16	5 31%	[6] 37%	5 32%
Rural	18	4 22%	4 22%	[10] 56%
7 One-shift	61	21 34%	[22] 36%	18 30%
Two-shift	11	3 27%	[5] 45%	3 27%
18 One-storey	25	3 12%	[12] 48%	10 40%
Two-storey	29	14 48%	[7] 24%	8 28%
Three-storey	10	5 50%	[4] 40%	1 10%
Four-storey	7	2 29%	[3] 42%	2 29%

AREA/STATION : LABORATORIES

The range of area/station in laboratories is from less than 1.5 to over 5 m^2. Graph 14 shows that a more generous area per station in general classrooms is generally matched by a greater area per station in laboratories.

GRAPH 14



SITE AREA/PUPIL

Information on size of site is available for 53 schools. The range of area per pupil is from 4 to 4000 m^2.

Matrix 15 examines site area for different types of schools and shows regional differences : African schools, about 80 m^2 median; Asian, 20 to 30 m^2; and Latin American, 10 to 20 m^2. As might be expected, boarding and rural schools have a high value: over 80 m^2 median; urban and day schools 20 to 30 m^2.

Single-storey schools have a median site area/pupil of 40 to 80m^2, three-storey schools have 20 to 30m^2 and four-storey, 10 to 20m^2, which reflects a pressure on urban building land. As such schools tend to be large, the actual site available for sports may be acceptable. Two-storey schools have just as much site area/pupil as single-storey.

MATRIX 15

TOPIC 37 SITE AREA/PUPIL

	Totals	10–	20–	30–	40–	80–	80+
Topic	53	5	9	10	[6]	7	16
11 Africa	32	2		7	2	5	[16]
Asia	9	3		[2]	2	2	
Latin America	12	3	[6]	1	2		
3 General secondary	45	2	8	7	5	[7]	16
Technical secondary	6	[3]	1	1	1		
Teacher training	2			[2]			
4 Boys	14			4	2	1	[7]
Girls	10		2		1	2	[5]
Co-ed	12		2	3	1	[2]	4
5 Boarding	21	1		2	2	1	[15]
Day	29	4	9	[8]	4	4	
Day + boarding	3					[2]	1
6 Urban	20	1	3	6	[ ]	5	5
Suburban	10	1		1	2	1	[5]
Rural	10			2	2		[6]
7 One-shift	47	5	7	9	[4]	6	16
Two-shift	6		2	1	[2]	1	
18 One-storey	16	1		2	4	[2]	7
Two-storey	18		4	3	1	[2]	8
Three-storey	12	2	3	[3]		3	1
Four-storey	6	2	[2]	2			

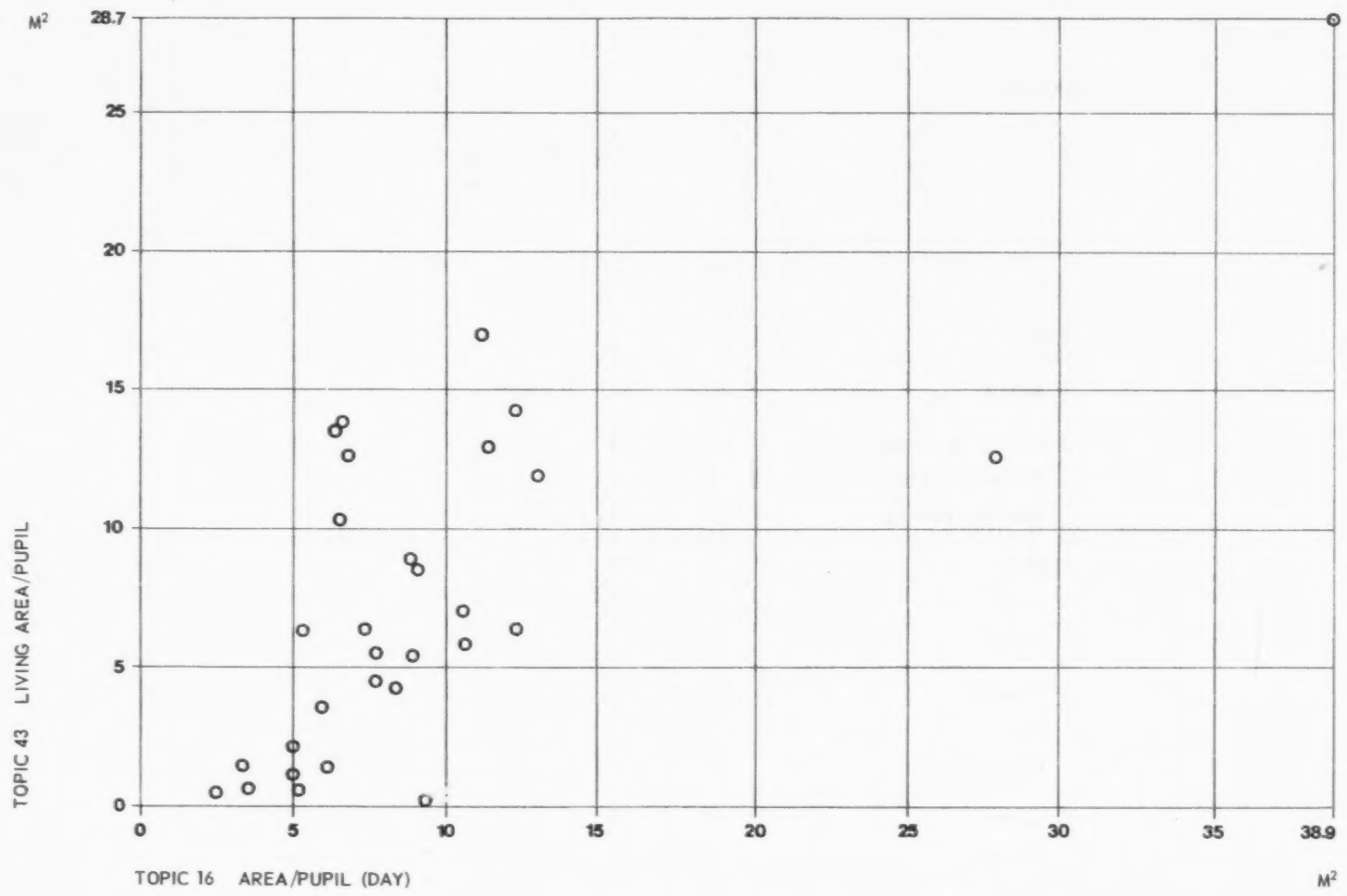
LIVING AREA/PUPIL

Thirty-three of the schools studied have residential or boarding accommodation. The number of boarders is not always stated, so living area per pupil may not reflect the amount of space needed to house one pupil.

Graph 16 shows living area per pupil against day school area per pupil. Living area ranges from under 1 to over 14 m^2 per pupil but in schools with boaders only, the lower limit is about 4 m^2. There is some correlation between living and day areas.

Boarding schools may have a total area per pupil of from 9 to 27 m^2 when living area is added to a day area of from 5 to 13 m^2 per pupil.

GRAPH 16



POTENTIAL WORKING WEEK AND STANDARD WEEK

It was not recorded whether schools work five or six days in a week but six days would appear to be usual, resulting in a range of pupil hours per day of between 3.8 and 5.3, not including time spent in sport, meals or private study. A week of 44 periods of 40 minutes, or 29.3 hours, is used by the African Regional Institute for comparison purposes and has been used in this analysis. However, the potential use of buildings is far greater than 29.3 hours per week (under 5 hours per day).

UTILIZATION OF GENERAL CLASSROOMS

Matrix 17 shows utilization for different types of schools, all of which are in Africa. The median value for pupil hours in general classrooms is between 20 and 22 out of a median of between 26 and 27 hours per week that each group receives instruction. Most schools have a classroom base for each class or group and these rooms will therefore be used about 80 per cent of the school day if they are only used by the group based there.

MATRIX 17

TOPIC 71 HOURS/ROOMS: GENERAL CLASSROOMS

	Totals	20-	24-	28-	28+
Topic	43	16	[14]	7	6
1 Africa	43	16	[14]	7	6
3 General secondary	38	14	[12]	6	6
Technical secondary	2	1		1	
Teacher training	3	1	[2]		
4 Boys	20	9	[4]	5	2
Girls	13	[7]	5		1
Co-ed	8		[5]	1	2
5 Boarding	29	13	10	6	
Day	11	2	3	[1]	5
Day + boarding	3	1	[1]		1
6 Urban	18	5	[5]	2	6
Suburban	12	5	[3]	4	
Rural	13	6	[6]	1	
7 One-shift	43	16	[14]	7	6
18 One-storey	16	[11]	4	1	
Two-storey	19	5	[7]	4	3
Three-storey	7		2	[2]	3
Four-storey	1		1		

Note: Asian and Latin American schools not included

OVERALL UTILIZATION OF EDUCATION SPACE

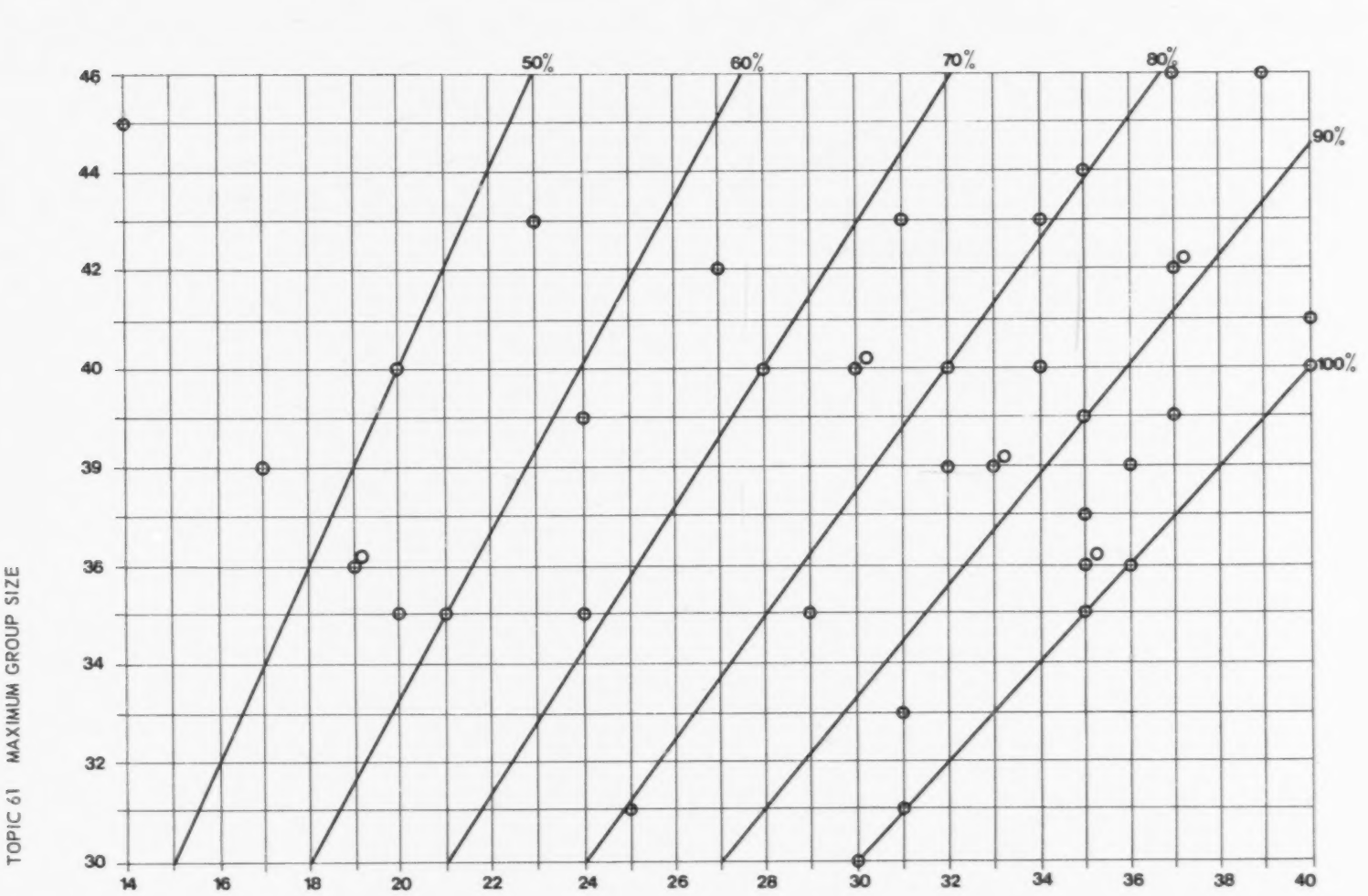
It is difficult to find a valid method for evaluating the overall utilization of a school. However, a sum of utilization of educational area (classrooms, laboratories and workshops) is possible.

The actual area per station in rooms (i.e. area per pupil available when the average group is using a room) is multiplied by the number of hours per week that the space is used to give an index figure which enables overall comparisons to be made. For example, a space which has 1.5 m^2 per station and which is used 20 hours per week would have an overall utilization of 30 m^2 hours/week/station which can be called space hours per week per station.

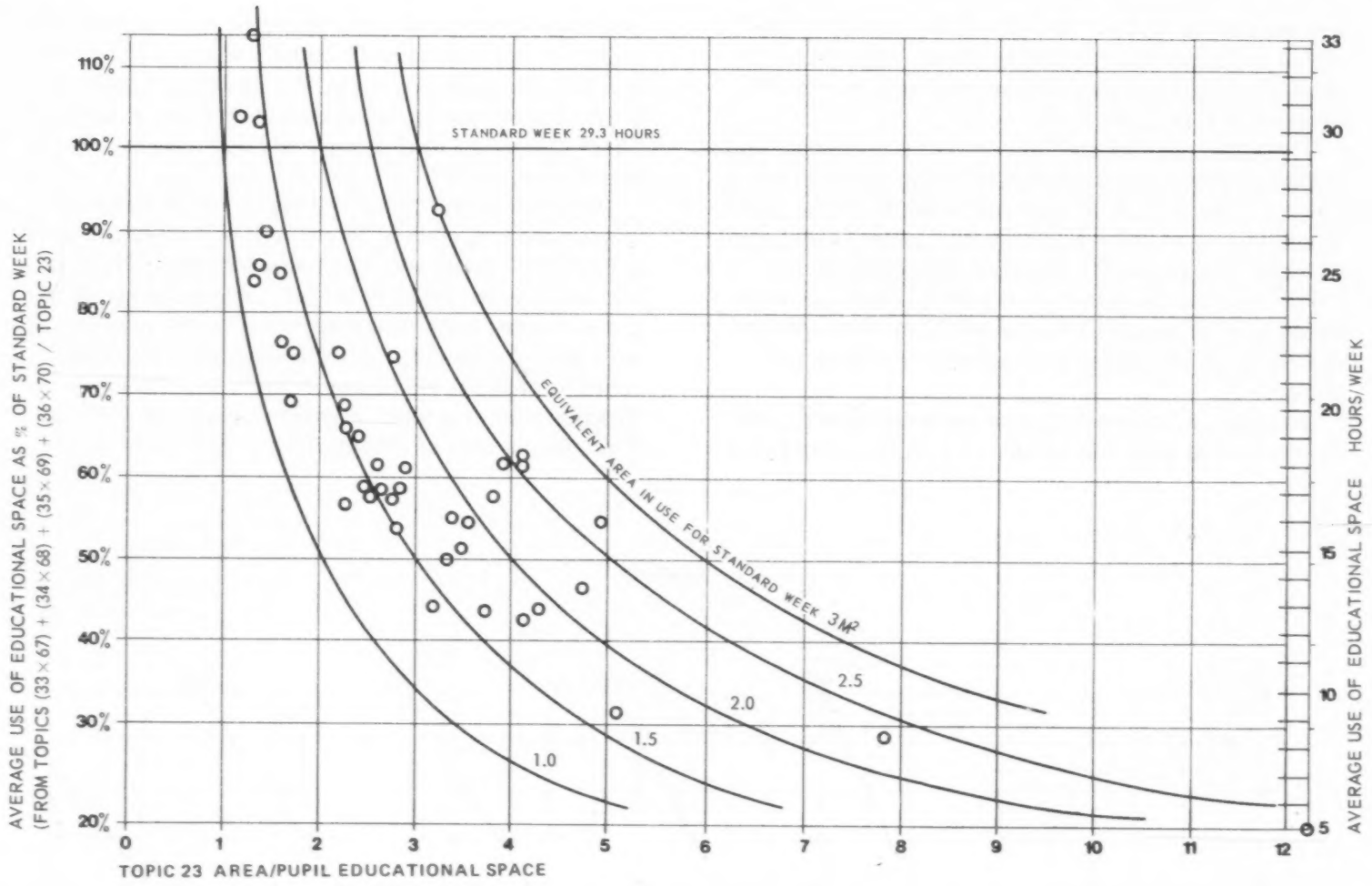
The space hours/week/station can be summed up for all educational areas and compared with the educational area/pupil in the school, multiplied by the standard week of 29.3 hours (this being the total space hours/pupil theoretically available per week). The result, as a percentage, is a measure of the use of all educational space. (Educational space has a median value of about 50 per cent of total school area.)

Graph 62 shows overall utilization of educational space, a median value of 60 per cent or 17.5 hours/week. Schools with lower area/pupil have a better utilization because they have mainly (or only) general classrooms. Lines showing equivalent area in use for the whole week have been drawn and, although educational area/pupil varies from about 1.5 to over 7.5 m^2, the area in use in all schools lies in a much narrower range from 1.25 to 3 m^2, 80 per cent of schools having under 2 m^2.

GRAPH 18



GRAPH 19


AVERAGE USE OF EDUCATIONAL SPACE AS % OF STANDARD WEEK
(FROM TOPICS (33×67) + (34×68) + (35×69) + (36×70) / TOPIC 23)
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
STANDARD WEEK 29.3 HOURS
EQUIVALENT AREA IN USE FOR STANDARD WEEK 3M²
2.5
2.0
1.5
1.0
0
1
2
3
4
5
6
7
8
9
10
11
12
TOPIC 23 AREA/PUPIL EDUCATIONAL SPACE
33
30
25
20
15
10
5
AVERAGE USE OF EDUCATIONAL SPACE HOURS/WEEK

Details of cost of buildings and their site, equipment and furnishing costs proved difficult to obtain. A considerable range of costs per m^2 and costs per place does emerge but, as all cost figures are expressed in US dollars using current exchange rates, these may need to be modified to take account of the cost of living in each country. Such an exercise is outside the scope of this study.

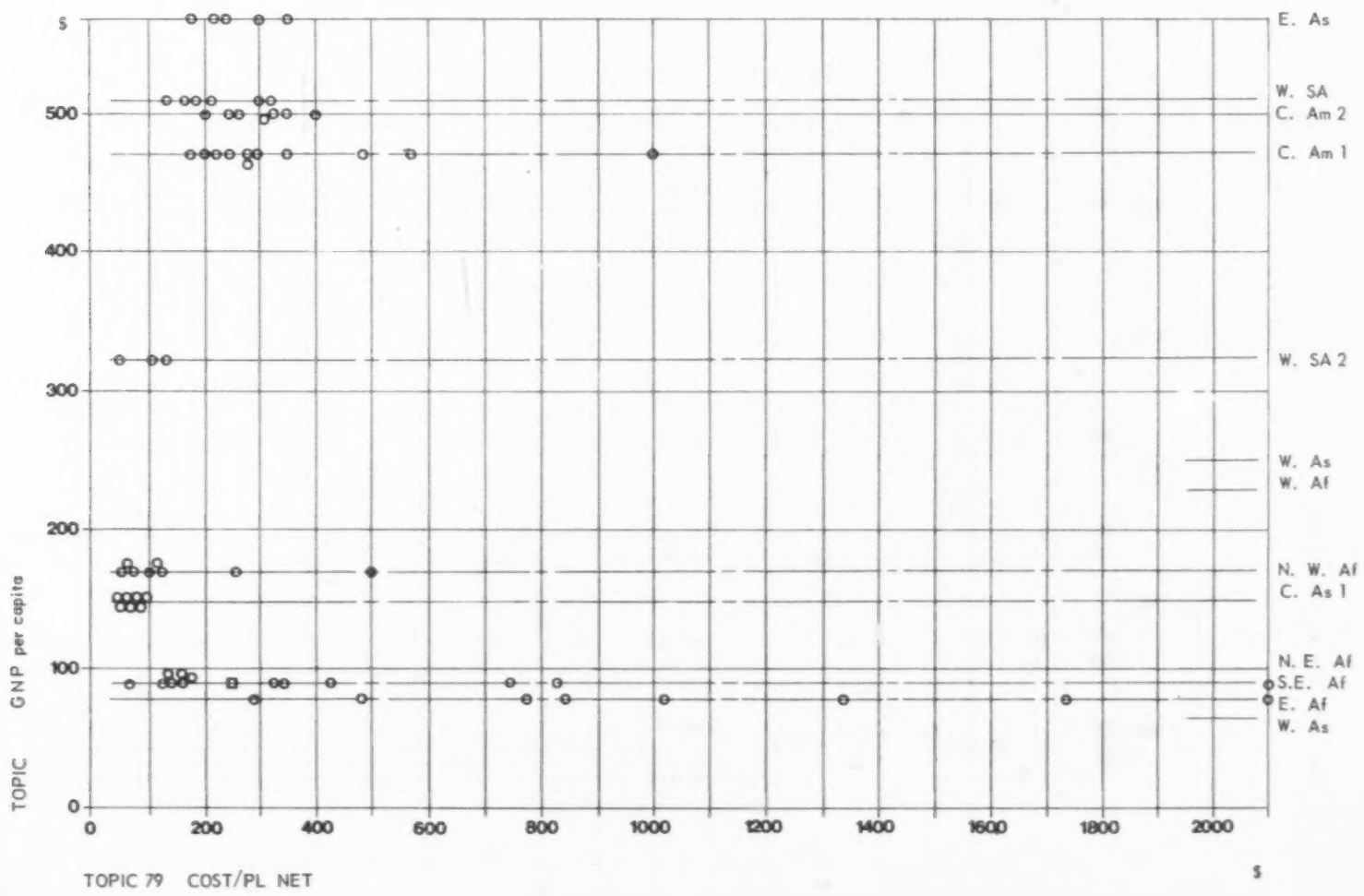
COST/PUPIL

The cost per pupil net varies from $49 to $2100, with a median value of $250 per pupil.

Graph 20 shows cost per pupil against GNP per capita in each country. The more prosperous the country, the greater the expenditure per pupil. A linear relationship of 1:2 is a good basis for comparison in countries having a GNP per capita of more than $100 (the UK operates a cost limit of about $900 per pupil and has a GNP per capita of $1600). However, the poorer countries tend to have many schools built at a much higher cost per pupil.

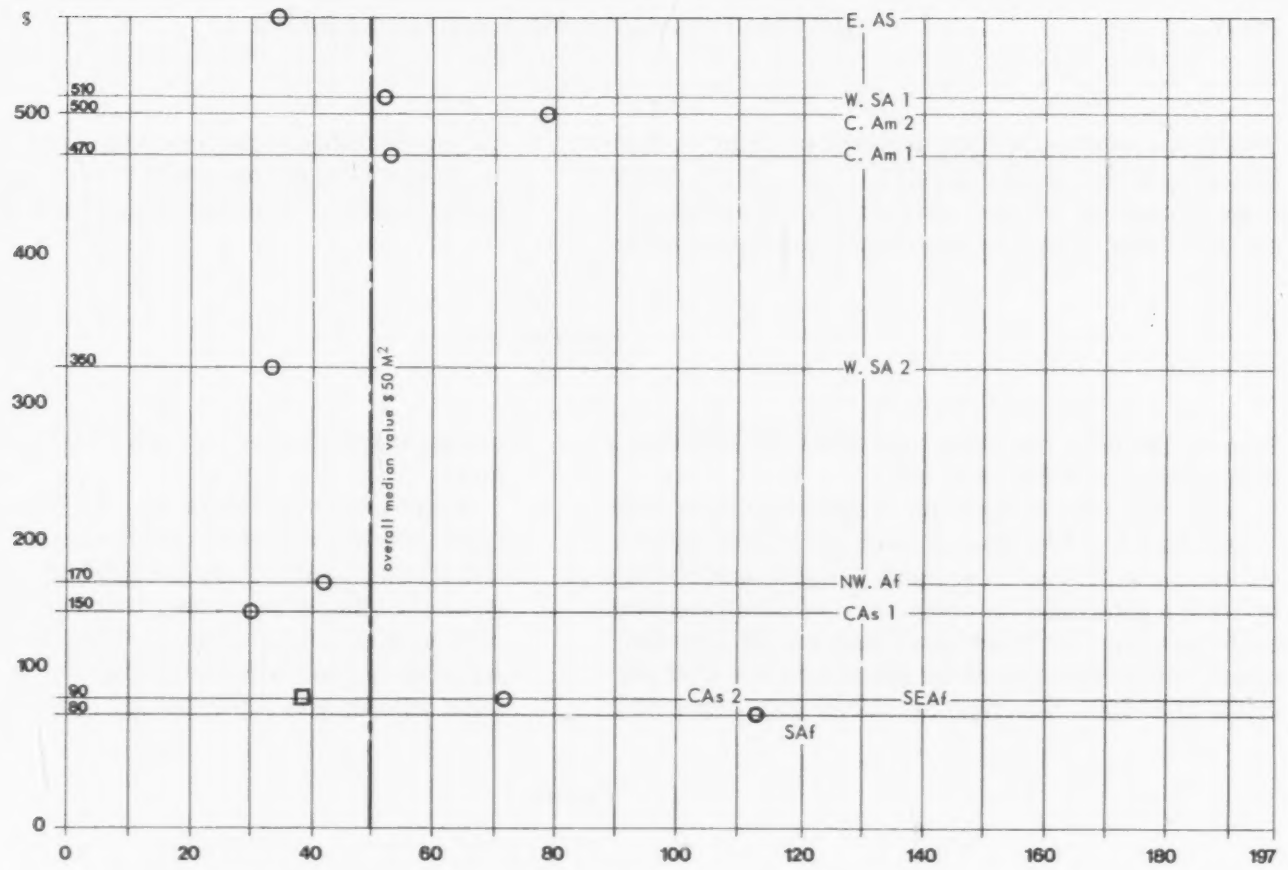
Graphs 21 and 22 show the relationships between the basic units of measure of cost per pupil (cost per sq. metre and area per student) and the GNP per capita at the time when the schools were built. This illustrates the specific policies which certain countries need to re-examine. Most particularly, countries with a low GNP can ill afford to build schools with high areas per student.

GRAPH 20



TOPIC 79 COST/PL NET

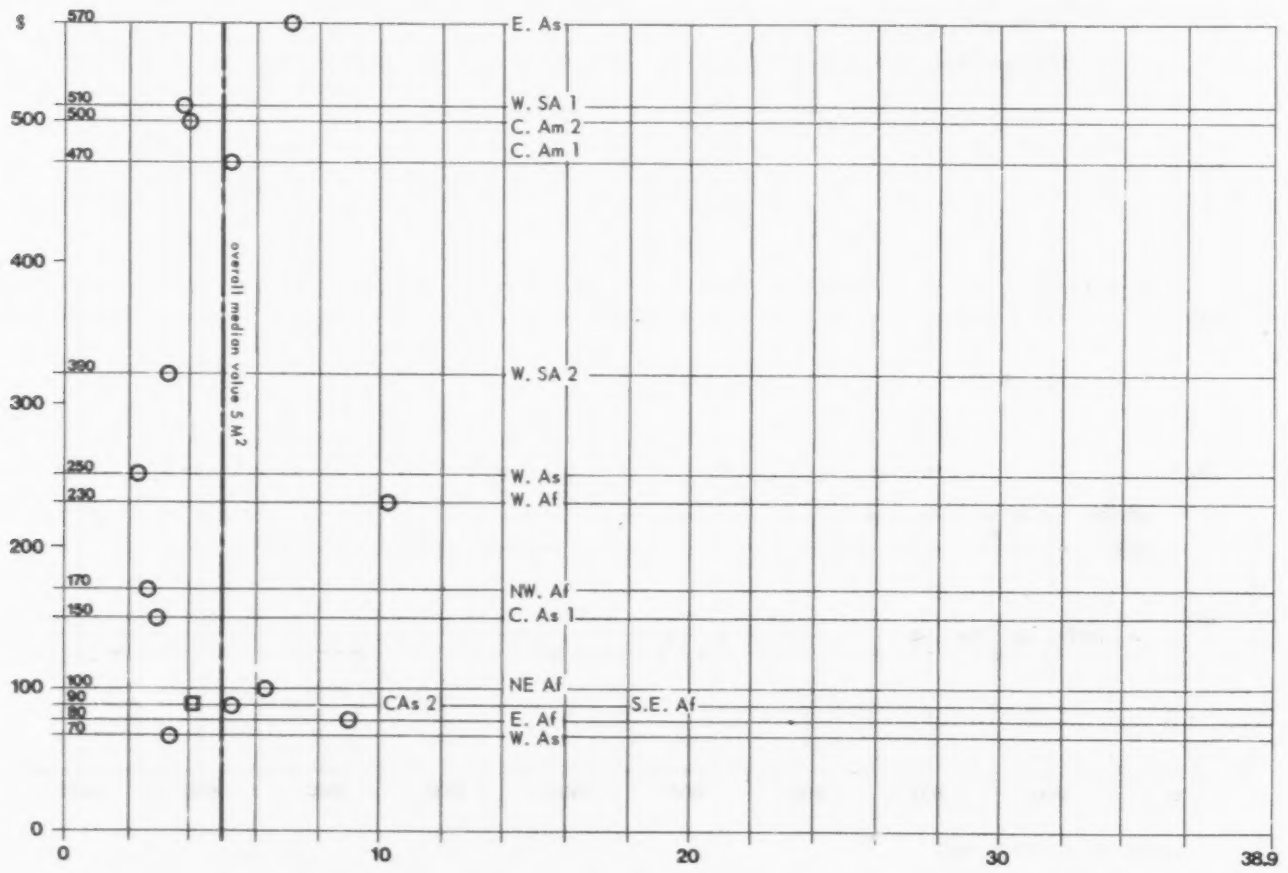
GRAPH 21



TOPIC GNP per capita (1966 - World Bank)

TOPIC 85 COST/M² NET NATIONAL MEDIAN VALUES

GRAPH 22



TOPIC GNP per capita (1966 - World Bank)

TOPIC 16 AREA/ENROLLED PUPIL NATIONAL MEDIAN VALUES

COST/M^2 NET

The median cost per m^2 is $50 but the range found is from $22.6 to $197. Graph 23 shows the cost per pupil, cost per m^2 and area per pupil. Lines indicating mean, maximum and minimum cost per m^2 are shown.

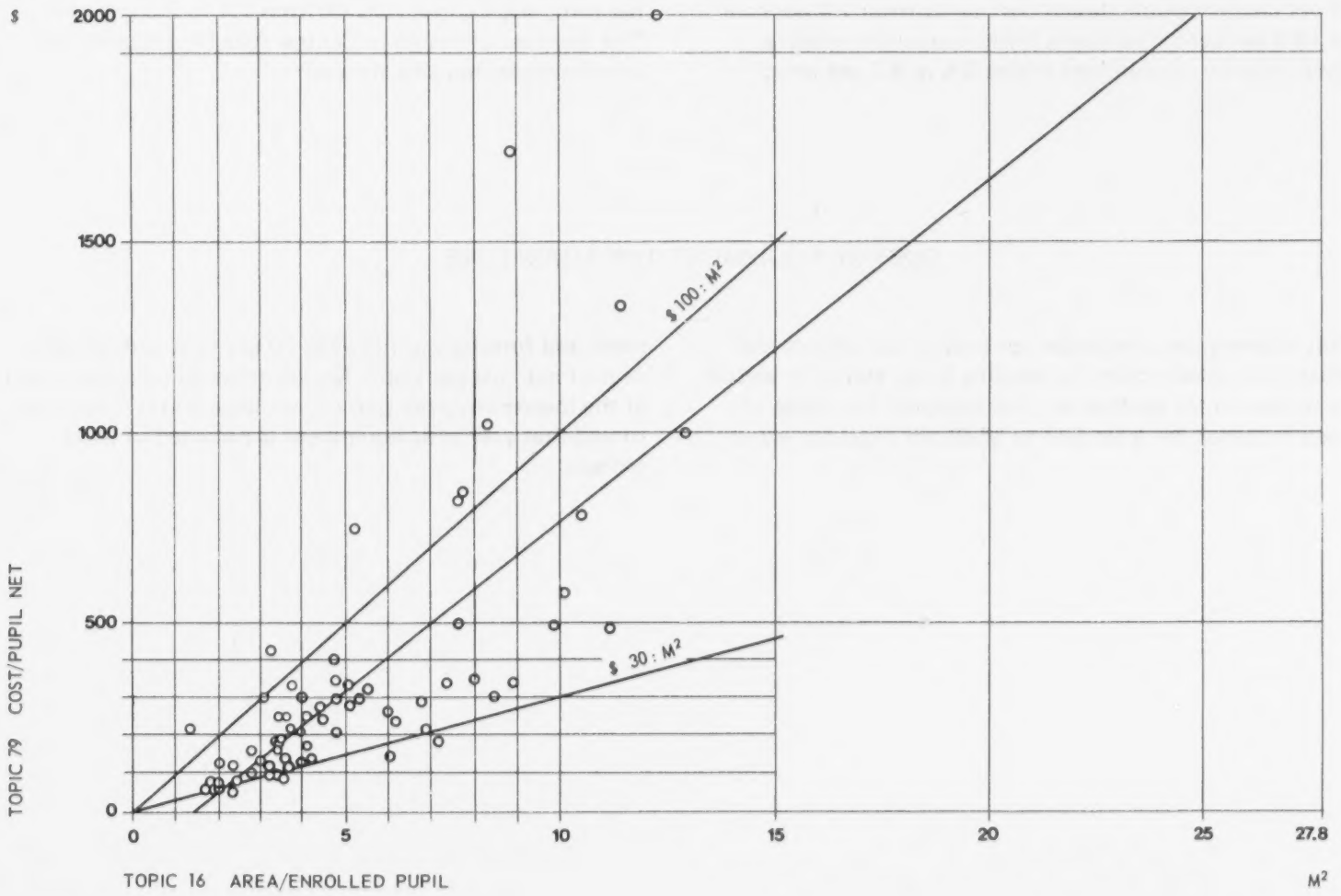
Cost per pupil and area per pupil result from dividing total cost and total area by the number of enrolled pupils. Nevertheless, a marked relationship between cost per m^2 and cost per pupil can be seen. The greater the cost per m^2 the larger the area per pupil and consequently cost per pupil.

A regression line has been shown on graph 23. Although the ranges of values found are wide (schools with cost per pupil of $250 can cost from $30 to $80 per m^2 while schools built at $50 per m^2 can have a cost per pupil of from $100 to $500) the regression line formula of cost per pupil = $15 x (area/pupil)^2 - (area/pupil) gives a good approximation to median values over the range 3 to 10 m^2.

Area/pupil	Cost/m^2	Cost/pupil
3	30	90
4	45	180
5	60	300
6	75	450
7	90	630
8	105	840
10	135	1 350

It is significant that each extra square metre of area per pupil increases the overall cost per m^2 by $15. A doubling of the cost per pupil gives a 33 per cent increase in area per pupil compared to a 50 per cent increase in cost per m^2. This may indicate that space provision is controllable at design stage but that specification and cost of the building are less so when more money is available. Matrix 24 shows how cost per m^2 varies between the three regions studied.

GRAPH 23



MATRIX 24

TOPIC 85 COST/m^2 NET

	Totals	30 -	40 -	50 -	70 -	70 +
Topic	71	7 10%	20 28%	[11] 15%	24 34%	9 13%
Africa	24	1 4%	6 25%	4 17%	[9] 37%	4 17%
Asia	19	5 26%	[11] 58%		3 16%	
Latin America	28	1 4%	3 11%	6 21%	[13] 46%	5 18%

COST OF DESIGN

Design cost is recorded for 28 schools and ranges from under $1 per pupil to over $300. Expressed as percentages of net cost per pupil, design cost varies from 1.4 per cent to 16.8 per cent. The rate is fairly consistent within a given country, North-West Africa 4.6 to 8.7 per cent; East Africa 12.2 to 15.7 per cent; Central Asia (2) from 12.3 to 16.8 per cent; South-East Africa, 2.5 and 5.4 per cent; and Central Asia (1)from 1.4 to 2.0 per cent. The low cost of design in Central Asia (1) is due to the use of simple standard structures.

COST OF EQUIPMENT AND FURNITURE

This information is recorded for only a few schools and what is included under this heading is not stated. It would be unwise to try to draw any conclusions. The range of costs recorded are from $47 to $549 per pupil for equipment and furniture or between 20 per cent and 30 per cent of net cost per pupil. No information on schools built at the lowest costs per pupil is available and it may be assumed that very little equipment is provided in these schools.

APPENDIX VI

A METHOD FOR DETERMINING TEACHING ACCOMMODATION NEEDS

by Jacques Soulat

This document has been prepared at the request of the Educational Building Section, Department of Planning and Financing of Education, as a result of evidence that teaching accommodation in many schools around the world is not efficiently used. This paper is intended to help both central administrations and headmasters to determine space needs for efficiently used premises.

The contents of this document are the views of the consultant and are not to be regarded as Unesco policy.

INTRODUCTION

From experience it is clearly evident that most school buildings are not efficiently used. Ont of the reasons for that low use factor lies in the poor administrative organization of schools particularly at the secondary level. The situation would be greatly improved by shifting the school organization from the present form (class) room system to the subject room system. Such a change would avoid teaching spaces being unoccupied during lesson time. This would permit headmasters to increase school enrolments without increasing facilities. In the case of schools in the planning stage, fewer teaching spaces would need to be built than have been built for schools using form rooms.

The purpose of this paper is to draw up a simple method for estimating teaching space needs according to the subject room system; this will enable central administrations as well as headmasters to plan their school building expansion programme responsibly, knowing how much space they already have and whether it is being used to greatest advantage.

This work contains an explanation of the methodology and its application to real cases drawn from a recent experience in Africa: a new combined secondary and terminal school in North Africa and an existing secondary academic school in East Africa.

The simplest method for determining the number of each kind of teaching spaces required for a given secondary school can be expressed as $S = \frac{L}{U}$ where :

S = Needed teaching spaces

L = Total subject loading per week

U = Room use per week

1. The total subject loading depends both on the curriculum and on the anticipated or present enrolment of the school. It is obtained by multiplying the number of weekly teaching periods per subject with the number of projected or existing classes.

Example : assuming a 10-class school where each class would have the same number of teaching periods per subject irrespective of grade :

SUBJECTS	No. of weekly teaching periods	No. of classes	Subject loading per week L
Mother tongue	6	10	60
Foreign language	4	10	40
History	4	10	40
Geography	4	10	40
Mathematics	6	10	60
Religious instruction	2	10	20
Science	4	10	40
Music	2	10	20
Physical education	2	10	20
Total	34	90	340

2. The room use is determined by the potential number of periods per week during which a room could be occupied, according to the weekly routine which is or will be followed by the school, reduced by 10 per cent for small schools and 20 per cent for large comprehensive schools for flexibility in arranging the time-table*.

EXAMPLE — Weekly routine

Monday to Friday 8 p. x 5 = 40 p.

8.40 - 9.25 First period
9.35 - 10.20 Second period
10.30 - 11.15 Third period
11.25 - 12.10 Fourth period
12.10 - 13.55 Lunch break
14.00 - 14.45 Fifth period
14.55 - 15.40 Sixth period
15.50 - 16.35 Seventh period
16.45 - 17.30 Eighth period

Saturday 4 p.

8.40 - 9.25 First period
9.35 - 10.20 Second period
10.30 - 11.15 Third period
11.25 - 12.10 Fourth period

In that case the room use would be U = 44 periods - 4 periods (10 %) = 40 periods

* The flexibility factor will vary according to the complexity of the pedagogic organization of the school.

3. The resultant, which should be calculated separately for rooms allotted to the teaching of academic subjects on the one hand and of specialized subjects on the other, is rounded *upwards* to the nearest whole integer.

Example :

Number of rooms needed for academic subjects :

Mother tongue	60
Foreign language	40
History	40
Geography	40
Mathematics	60
Religious Instruction	20
Total	260

Divided by 40 periods : $\frac{260}{40} = 6.5$ rounded up to 7 classrooms

Number of rooms needed for specialized subjects :

Science 40

Divided by 40 periods : $\frac{40}{40} = 1$ laboratory

Music 20

Divided by 40 periods : $\frac{20}{40} = 0.50$

Physical Education 20

Divided by 40 periods : $\frac{20}{40} = 0.50$

} 1 multi-purpose gymnasium

Thus, the number of teaching spaces needed for that particular school would be :

7 ordinary classrooms
+ 1 science laboratory
+ 1 multi-purpose gymnasium
9

4. Following are two applications and several blank forms which may be used for assessing the capacity of existing schools and for determining room needs for new building programmes.

A NAME AND LOCATION		B MODEL SCHEDULE OF TEACHING ACCOMODATION																C	D	
		Secondary School							Terminal School											
Secondary and Terminal School North Africa Type: Day, Boarding	Grade	1	2			3			4			5			6			Total Subjects Loading (Periods)	Length of Period	1
	Stream		Acad.	Ec.	Tech.	Acad.	Ec.	Tech.	Gen.	Com.	Ind.	Gen.	Com.	Ind.	Gen.	Com.	Ind.		Potential room use	37
																			Flexibility factor	10
Enrolment 1,200	No. Classes	6	4	1	1	4	1	1	1	1	3	1	1	3	1	1	3		Room use	34

																			Number of needed teaching spaces	Number of existing spaces	
Subjects taught in ordinary rooms	Mother tongue	48	24	6	6	24	6	6	5	5	12	5	5	9	5	5	9	180			
	Second language	36	20	5	5	20	5	5	5	5	12	5	4	9	5	4	9	154			
	Foreign language		16	4	3	16	4	3	3	3		3	3		3	3		64			
	Mathematics	18	15	4½	5	15	4½	5	4	4	12	4	3	13½	4	3	13½	128			
	Civics & Religious instruction	9	6	1	1	6	1	1	2	2	3	2	1	3	2	1	3	44			
	Music		4			4												8			
	History & Geography	12	8	2	2	8	2	2	2	2	4½	2	2	4½	2	1	4½	60½			
																	Total	632	19		
Subjects taught in special rooms	Drawing	12	4	1		4	1		2	2		2			2			30	1		
	Biology	18	8	2	1	8	2	1	1	1	1½	1	1½	1				47½			
	Physics & Chemistry				2			2	2	1	3	2	1½	6	2		7½	29			
																		25+			
																		101	3		
	Typing						2			4			4			3		13			
	Shorthand												3			3		6			
	Accountancy			1			2						3			5		11			
	Commerce			1			1						1			5		8			
																		38	1		
	Technical drawing				4			5			12			12			12	45			
	Technology										4½			4½			4½	13½			
																		58½	2		
	Physical education	18	12	3	2	12	3	2	2	2	3	2	2	3	2	2		70	2		
	Woodwork & Metalwork	18	8			8			2			2			2			40			
	Technical training										54			57			63	174			
																		214	7		
																		Total	35		

+ 1/3 of the Science teaching is devoted to practical work for which the class is split in two groups. Consequently 1/3 more periods have been added.

A NAME AND LOCATION	B MODEL SCHEDULE OF TEACHING ACCOMODATION																C Total Subjects Loading (Periods)	D Length of period	
Boys Secondary Academic School East Africa	Grade	1	2		3			4			5			6				Potential room use	
	Stream				S.		A.	S.		A.	S.		A.	S.		A.			
Enrolment 540	No. Classes	3	3		2		1	2		1	1		1	1		1		Flexibility factor	%
																		Room use	
Subjects taught in ordinary rooms	Mother tongue	9*	9		6		3	6		3							36		
	Second language	27	27		18		9	18		9			8			8	124		
	History	12	12				4			4			8			8	48		
	Mathematics	21	21		22		6	22		6	14			14			126		
	Art	6	6				8			8							28		
	Economics												8			8	16		
	General paper										4		4	4		4	16		
	Religious instruction	6	6		4		2	4		2							24		
																		Number of needed teaching spaces	Number of existing spaces
																Total	418	11	16
Subjects taught in special rooms	Geography	12	12		8		4	8		4			8			8	64	2	1
	Physics	9	9		8			8			8			8			50		
	Chemistry	9	9		8			8			8			8			50		
	Biology	9	9		8			8			8			8			50		
																	150	4	4
	Woodwork & Metalwork	9	9		3		6	3		6							36	1	1
																Total		18	22

A NAME AND LOCATION	B SCHEDULE OF TEACHING ACCOMMODATION																		C	D	
Type : Day, Boarding	Grade	1	2			3			4			5			6				Total Subjects Loading (Periods)	Length of period	
																				Potential room use	%
Enrolment :	Stream																			Flexibility factor	
	No. Classes																			Room use	

																						Number of needed teaching spaces	Number of existing spaces
Subjects taught in ordinary rooms																							
Subjects taught in special rooms																							

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Southern Rhodesia	Textbook Sales (PVT) Ltd., 67 Union Avenue. SALISBURY.
Singapore	Federal Publications Sdn Bhd., Times House, River Valley Road, SINGAPORE 9.
South Africa	Van Schaik's Bookstore (Pty.) Ltd., Libri Building, Church Street, P.O. Box 724, PRETORIA.
Sudan	Al Bashir Bookshop, P.O. Box 1118, KHARTOUM.
Sweden	*All publications:* A/B. C.E. Fritzes Kungl. Hovbokhandel, Fredsgatan 2, Box 16356. 103 27 STOCKHOLM 16. *For 'The Courier':* Svenska FN-Förbundet, Vasagatan 15, IV, 101 23 STOCKHOLM 1. Postgiro 18 46 92.
Switzerland	Europa Verlag, Rämistrasse 5, ZÜRICH; Librairie Payot, 6, rue Grenus, 1211 GENÈVE 11.
Tanzania	Dar es Salaam Bookshop, P.O. Box 9030, DAR ES SALAAM.
Thailand	Suksapan Panit, Mansion 9, Rajdamnern Avenue, BANGKOK.
Turkey	Librairie Hachette, 469 Istiklal Caddesi, Beyoglu, ISTANBUL.
Uganda	Uganda Bookshop, P.O. Box 145, KAMPALA.
U.S.S.R.	Mezhdunarodnaja Kniga, MOSKVA, G-200.
United Arab Republic	Librairie Kasr El Nil, 38, rue Kasr El Nil, LE CAIRE. *Sub-depot:* La Renaissance d'Égypte, 9 Sh. Adly Pasha CAIRO (Egypt).
United Kingdom	H.M. Stationery Office, P.O. Box 569, LONDON S.E.1; Government bookshops: London, Belfast Birmingham, Cardiff, Edinburgh, Manchester.
United States	Unesco Publications Center, P.O. Box 433, New York, N.Y. 10016.
Yugoslavia	Jugoslovenska Knjiga, Terazije 27, BEOGRAD. Drzavna Zaluzba Slovenije Mestni Trg. 26 LJUBLJANA.

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